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HERPETOLOGICA

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Secretary-Treasurer and Publisher, Chapman Grant,

Route 1, Box 80, Escondido, California

Edited by the Officers. Policies determined by the Members. $4.00 per volume

Vol. 13 October 31, 1957 No. 3

UNIVERSITY OF MICHIGAN

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The Morphology of the Thyroid Gland in the Lacertilia[1]

W. GARDNER LYNN and GEORGE A. WALSH, O.S.F.S.

There is now considerable information concerning the morphology and physiology of the thyroid gland in fishes, amphibians, birds and mammals, but the reptilian thyroid is relatively little known (Lynn and Wachowski, 1951). Several recent general papers on the thyroid, as well as most recent text-books of comparative anatomy, dismiss the reptiles with the simple statement that in this group the thyroid is an unpaired gland situated ventral to the trachea and immediately anterior to the heart. This generalization is no doubt based primarily upon observations on the turtle, the reptile most commonly used for dissection in comparative anatomy courses. A search of the literature indicates that an unpaired thyroid is probably characteristic of all turtles and may also be the usual condition in snakes and crocodilians. This does not apply, however, to the lacertilians. In this group of reptiles the thyroid varies, in different species, from an unpaired gland to two completely separate glands, with some species having a bilobed thyroid connected by an isthmus. This fact was first noted by Simon (1844), who has been credited with being the first to correctly distinguish the thyroid from the thymus in lower vertebrates. Simon's consideration of the lacertilian thyroid is contained in only three short paragraphs, but he points out that the general form of the gland seems to differ in different families of lizards, and specifically mentions the relations of the thyroid in representatives of the following groups: Lacertidae, Iguanidae, Gekkonidae, Chameleonidae, Scinidae, and Amphisbaenidae.

Most later references to the morphology of the thyroid in lizards are found as incidental observations in papers dealing primarily with other aspects of reptilian anatomy. Only a few of these warrant notice here.

[1]A contribution from the Department of Biology, The Catholic University of America, Washington, D. C. This paper is based, in part, on the junior author's dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science.

We are deeply indebted to Dr. Doris M. Cochran for making available many of the specimens used in this study and for permitting us to expose and study the thyroid region in some of the lizards in the collections of the United States National Museum.

Van Bemmelen (1886) and O'Donoghue (1920), in considering the blood vessels of the cervical region, provided some information on the thyroid of *Sphenodon* and a few lizards. Bhatia and Dayal (1933) described the thyroid of *Hemidactylus.* Bourne (1935) gave an account of the gland in *Egernia.* Adams (1939) discussed the vascular supply of the thyroid in *Lacerta* and made comparisons with some other genera. Eggert (1933) and Weigmann (1932) described the embryology and morphology of the thyroid in *Lacerta.* Miller (1955) gave an account of the seasonal changes in the histology of the thyroid in *Xantusia.*

It is clear that, although differences in thyroid morphology in different lizards have been known, they have been largely neglected or lost sight of, and there has been no attempt at a comprehensive comparative study of the subject. In view of the large number of lacertilian families now recognized (approximately 26) and of the many unsolved questions concerning the exact taxonomic position and interrelations of certain genera, such a comparative study, aside from its intrinsic interest, might conceivably throw some light on taxonomic problems. The present study is a preliminary step towards such an investigation. Dissections have been carried out on at least a few representatives of as many as possible of the families of lizards. Two families, the Pygopodidae and the Amphisbaenidae, which have been subjected to a more detailed study will be discussed in a separate paper and are not considered here. Three families, the Lanthanotidae, the Anelytropsidae, and the Dibamidae are not represented in the material available to us. This paper thus includes data for a total of 21 families.

Most of the specimens used had been preserved in either alcohol or formaldehyde; some, however, were deep-frozen after death and were dissected before preservation. Dissection of all but the largest lizards was carried out under a binocular microscope equipped with wide-field oculars. For a few genera of small lizards, such as *Sphaerodactylus,* the results of the dissection were checked by examination of serial sections of the entire head and neck. The details of the anatomical relations of the thyroid differ in the various forms studied and, as Camp (1923) has shown, the throat musculature which underlies the thyroid exhibits rather marked specialization in certain lizard families. In all the dissections the musculature and the blood vessels of the throat region were studied in detail. These matters will not be discussed in the present paper, however, which will be limited to brief presentation of the findings concerning the form of the thyroid gland in the animals studied.

At the beginning of this work 25 specimens of a common Jamaican species (*Anolis lineatopus* Gray) were dissected, both to gain experience in technique and to obtain some information concerning individual variation in thyroid form within a species. All specimens were found to agree closely, possessing paired thyroids, usually embedded in the dorsal surface of a fat body lying just anterior to the sternum, each gland being approximately three times as wide as long. The lack of variation in this species cannot, of course, be taken as any proof that other species have a similar constancy in this character and, unfortunately, for most other lizards studied, only a relatively small number of specimens was available.

In order to present the results in brief compass the following list has

been prepared in which the form of the thyroid has been classified into two main types, each with three sub-types, and the various lizards showing each condition have been listed. The number in parentheses after each species is the number of specimens examined.

A—Thyroid with two distinct lobes:

1—Lobes completely separate (paired thyroid glands).

Gekkonidae: *Aristelliger praesignis* (3)
Iguanidae: *Anolis lineatopus* (25), *A. opalinus* (3), *A. garmani* (5), *Xiphocercus valenciennesii* (5)
Agamidae: *Agama stellio* (1)
Varanidae: *Varanus salvator* (1), *Varanus niloticus* (1)
Helodermatidae: *Heloderma suspectum* (2)
Anguidae: *Celestus c. crusculus* (3)
Ophisauridae: *Ophisaurus ventralis* (4)

2—Lobes connected by a narrow isthmus.

Gekkonidae: *Sphaerodactylus argus* (8), *S. goniorhynchus* (5), *Stenodactylus sthenodactylus* (1)
Eublepharidae: *Coleonyx variegatus* (3)
Shinisauridae: *Shinisaurus crocodilurus* (1)
Cordylidae: *Cordylus giganteus* (2)
Feylinidae: *Voltzkowia mira* (1)

3—Lobes connected by a broad isthmus.

Gekkonidae: *Ptyodactylus hasselquisti* (1)
Agamidae: *Agama mutabilis* (3)
Teiidae: *Ameiva dorsalis* (1)

B—Thyroid single:

1—Much broader than long (the width at least 10 times the length), forming a thin ribbon-like organ extending transversely across the trachea.

Gekkonidae: *Hemidactylus turcicus* (1), *Tarentola mauritanica* (2)
Xantusiidae: *Xantusia vigilis* (2)
Scincidae: *Egernia whitei* (3), *Eumeces fasciatus* (2), *Leiolopisma unicolor* (2)
Teiidae: *Tupinambis teguixin* (10), *T. nigropunctatus* (5)

2—Broader than long but not ribbon-like (width 3 to 8 times length).

Iguanidae: *Amblyrhynchus cristatus* (1), *Phyrnosoma cornutum* (12), *Sceloporus u. undulatus* (5)
Chameleontidae: *Chameleon hoehnelii* (4)
Cordylidae: *Chamaesaura anguina* (2)
Scincidae: *Chalcides sepsoides* (10) *Egernia cunninghami* (1) *Scincus officinalis* (4)
Gerrhosauridae: *Gerrhosaurus f. flavigularis* (1)
Lacertidae: *Acanthodactylus pardalis* (3), *A. scutellatus* (3), *A. boskianus* (3), *Lacerta agilis* (7)
Teiidae: *Cnemidophorus s. sexlineatus* (2)
Gerrhonotidae: *Gerrhonotus scincicaudus* (2)
Xenosauridae: *Xenosaurus grandis* (2)

3—Rounded, length and breadth approximately equal.

Uroplatidae: *Uroplatus capiteplanus* (2)
Feyliniidae: *Feylinia currori* (1)
Anniellidae: *Anniella pulchra* (6)

Examination of this list shows at once that, as Simon pointed out so long ago, the form of the thyroid differs markedly in different lizards. However, Simon apparently did not realize that great variations exist even within single familes of lizards. He remarks that "in this order—the gland . . . occupies different positions in different families," thus implying that all members of one family have the same type of thyroid. In this study most of the larger families proved to be heterogeneous in thyroid morphology even in the small number of genera investigated for each family. This is summarized in the following table in which the general arrangement of the families of lizards is according to Camp's classification.

TABLE 1

Family	Approx. no. genera	No. genera studied	No. species studied	Thyroid Paired	Unp.	Bilobed
ASCALABOTA						
Gekkonidae	75	6	7	+	+	+
Uroplatidae	1	1	1	−	+	−
Eublepharidae	5	1	1	−	−	+
Iguanidae	65	5	7	+	+	−
Agamidae	35	1	2	+	−	+
Chamaeleontidae	7	1	1	−	+	−
AUTARCHOGLOSSA						
Xantusiidae	4	1	1	−	+	−
Scincomorpha						
Scincidae	60	5	6	−	+	−
Feyliniidae	3	2	2	−	+	+
Gerrhosauridae	5	1	1	−	+	−
Lacertidae	30	2	4	−	+	−
Teiidae	40	3	4	−	+	+
Anguinomorpha						
Anguidae	8	1	1	+	−	−
Ophisauridae	1	1	1	+	−	−
Gerrhonotidae	1	1	1	−	+	−
Anniellidae	1	1	1	—	+	—
Cordylidae	3	2	2	−	+	+
Xenosauridae	1	1	1	−	+	−
Shinisauridae	1	1	1	−	−	+
Helodermatidae	1	1	1	+	−	−
Varanidae	1	1	2	+	−	−

Several groups (Eublepharidae, Uroplatidae, Shinisauridae, Ophisauridae, Gerrhonotidae, etc.) whose status is controversial, have been included as families, however, in order to facilitate comparison. For each family the approximate number of genera is given. The number of genera and species represented in our dissections and the type of thyroid found is then indicated (Table 1). It will be seen that among the representatives of the Gekkonidae which were dissected some species have an unpaired median thyroid, others have a paired thyroid, and still others have a bilobed thyroid. In the Iguanidae both single and paired glands were

found; in the Teiidae both median and bilobed conditions were encountered. In the Scincidae and Lacertidae, both fairly large families, the thyroid was unpaired in all of the species examined but since these represent less than 10% of the total number of genera in each family this result can be given but little significance.

The most recent attempt at a general classification giving the interrelations of all families of lizards is that of Camp (1923). It will be noted that the Ascalabota, which Camp considers the more primitive group, is made up of families showing a variety of thyroid forms. Among the Autarchoglossa the xantusids and all the scincomorphs agree in having unpaired thyroids (with *Voltzkowia* and some of the teiids showing a bilobed condition). The Anguimorpha constitute another group which is heterogeneous with respect to thyroid form. Judging by these results, one might conclude that on the basis of thyroid morphology alone the Scincomorpha is the only group which is homogeneous and accords with Camp's ideas of interrelationships. It must be remembered, however, that dissection of more representatives of this group might change this conclusion radically. In fact it now seems unlikely, that thyroid morphology will prove to be of much value in detecting interfamilial affinities. On the other hand it is quite possible that, if attention is shifted to a lower taxonomic level, this feature may prove quite useful in the study of intrafamilial relations.

Certain families whose status is controversial may merit special mention. The Eublepharidae, which is regarded as a distinct family by some authors (Boulenger 1885, Werner 1912, Underwood 1954), has been united with the Gekkonidae by others (Camp 1923, Smith 1933). This group is represented by *Coleonyx* in our study and was found to have a bilobed thyroid with a narrow isthmus. In this it accords with certain gekkonids (*Sphaerodactylus* and *Stenodactylus*) but, since other gekkonids show a diversity of thyroid forms, this throws no light on the problem. *Uroplatus,* which has been sometimes placed in the Gekkonidae and sometimes in a distinct family, proved to have an unpaired, rounded, thyroid. This type was uncommon in the lizards studied and was not found in any of the gekkonids we dissected. The two representatives of the Feyliniidae (*Feylinia* and *Voltzkowia*) differed widely in thyroid form which may indicate that they are not closely related. Unfortunately no specimens of *Anelytropsis,* which may have affinities with these forms, were available for study. Among the cordylids one (*Cordylus*) was found to have a bilobed thyroid whereas another (*Chamaesaura*) had an unpaired gland. *Chamaesaura* is a specialized serpentiform lizard and one might be led to suppose that the single, unpaired thyroid is somehow associated with this habitus. This is by no means the case, however, for while some elongate lizards with reduced limbs such as *Feylinia* and *Anniella* do have an unpaired thyroid others (*Voltzkowia*) have a bilobed gland and still others have completely separate thyroids (*Ophisaurus*). The thyroid of *Shinisaurus crocodilurus* is of special interest, for it is unique among those we have seen, not in its form, but in the fact that the two lobes, instead of lying alongside the trachea, extend very far dorsally. There is a narrow isthmus ventral to the trachea and from this point the two lobes pass caudally and dorsally until the distal ends, which are considerably ex-

panded, lie in the musculature dorsal to the heart and lateral to the vertebral column. The relations of *Shinisaurus* have recently been considered in some detail by McDowell & Bogert (1954) who have assigned it to a subfamily of the Xenosauridae.

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The Morphology of the Thyroid Gland in Lizards of the Families *Pygopodidae* and *Amphisbaenidae*[1]

W. Gardner Lynn and Louis A. Komorowski, O.S.F.S.

The two small families of lizards with which this paper deals present a number of morphological and taxonomic problems. The members of both groups are elongate, thin-bodied animals with the limbs greatly reduced or completely lacking. Because of their secretive habits, they are relatively rare in collections.

The family Pygopodidae, as currently conceived, contains eight genera most of which are monospecific. These lizards are snake-like in appearance. They have well developed scales, the eyes lack movable eyelids, and the forelimbs are absent. The hindlimbs are present as small rudiments in most pygopodids, but both fore- and hindlimbs are absent in *Aprasia*. The tail is elongate in most forms but relatively short in *Aprasia*. There is evidence that, despite the elongation of the body and reduction of limbs, most pygopodids are surface-living forms rather than burrowers. Members of the Pygopodidae are not found beyond the limits of the Australia-New Guinea-Tasmanian region.

The family Amphisbaenidae contains some twenty genera of lizards which show considerably greater specialization than the pygopodids in skull characters, body musculature and various other features. All appear to be active burrowers, many living exclusively in ant and termite nests. The body is covered with a soft skin, forming numerous rings which give it a worm-like appearance. The eyes are vestigial and partially concealed beneath the skin. The external ear opening has been lost, the tail is extremely short, and both fore- and hindlimbs are absent in all but one genus. This genus, *Bipes*, has rudimentary forelimbs but has lost the hindlimbs. The amphisbaenids are noteworthy in that the right lung is lost or rudimentary. Snakes and other elongate lizards which have reduced lungs all show reduction of the left lung. The Amphisbaenidae are found throughout the tropics except in Australasia, the Oriental region, and Madagascar.

In early attempts at classification of the reptiles there was often a tendency to lump together such specialized elongate forms and to regard them as closely related. It was soon realized, however, that this particular habitus has been developed independently in a number of groups and that a careful search for characters of phylogenetic significance is necessary to reveal the true relationships. Camp (1923), who has made the most comprehensive attempt to evaluate lacertilian morphology from this point of

[1]A contribution from the Department of Biology, The Catholic University of America, Washington, D.C. This paper is based, in part, on the junior author's dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science. We are deeply indebted to Dr. Doris M. Cochran for permission to expose and study the thyroid region in some specimens in the collections of the United States National Museum.

view, concludes that the pygopodids and the amphisbaenids are not at all closely related. He regards the Pygopodidae as diploglossids while the Amphisbaenidae are considered as scincomorphs. Camp's conclusions are based on analysis of 34 anatomical features, some skeletal and some involving soft parts. In general, it is clear that features which are not of adaptive significance in relation to burrowing or grass-living habits are the most important ones in revealing relationships for the two groups under consideration, since they tend to retain primitive conditions unobscured by specialization. The present study deals with such a feature, the morphology of the thyroid gland, and may therefore contribute one further point of evidence concerning the taxonomic position of these lizards.

So far as can be ascertained no description of the thyroid has ever been given for any member of the Pygopodidae. The amphisbaenid thyroid is mentioned by Simon (1844) who, however, regarded this group as constituting a distinct order of reptiles rather than belonging to the lizards. His consideration of the thyroid is contained in a single sentence: "The thyroid gland in the amphisbaenians occupies exactly the same site and relations as in the true serpents." Hoffman (1890) simply repeats this remark, and it appears that no attempt to investigate the matter further has been made since Simon's time.

MATERIALS AND METHODS

All specimens used for this study are in the collections of the United States National Museum. Dissection was carried out under the binocular microscope using fine scissors and watchmaker's forceps. A mid-ventral incision was first made in the skin from just behind the head to the level of the heart, taking care not to injure the specimen for taxonomic work. After the skin had been laid back, the musculature of the throat was studied and the successive layers of muscles were reflected as far as necessary to reveal the relations of the thyroid to the heart, trachea, and blood vessels. Since, as will be seen, the size, shape, and position of the gland differed markedly in the various forms examined, a detailed search using the higher powers of the binocular was often necessary before the precise morphological details could be ascertained with certainty.

After observations and measurements had been completed, each specimen was photographed to show the thyroid *in situ*. The gland was then removed, dehydrated in cellosolve, embedded in paraffin and sectioned at 5 micra. The sections were stained with Mallory's triple stain, and a routine study of the sections was made in order to confirm the identification of the tissue as thyroid. In some of the lizards a rounded mass just anterior to the heart which presented some of the gross features of thyroid tissue was also sectioned, but in every case this proved to be a fat body.

OBSERVATIONS

1. PYGOPODIDAE

Delma fraseri Gray U.S.N.M. No. 128260, Nightcliff, Australia. The thyroid was found immediately dorsal to the common origin of the m. pectoralis and the m. sternohyoideus. It was an unpaired but definitely bilobed body and lay just above the heart in the fork of the brachiocephalic artery. As may be seen in the photograph (Fig. 1), the gland was

V-shaped, the two limbs of the V straddling the trachea ventrally. The extreme antero-posterior measurement of the gland was 1.5 mm. and the extreme lateral measurement was the same; each limb of the V measured approximately 2.0 mm. by 0.5 mm.

Lialis burtoni Gray U.S.N.M. No. 128468, Australia. The thyroid was single and without lobes. Its position agreed closely with that described for *Delma fraseri.* It was flattened and roughly discoidal in shape with a diameter of 2.0 mm. (Fig. 2).

Pygopus lepidopus (Lacepede) U.S.N.M. No. 59943, Newtown, Australia. The thyroid was unpaired and occupied the same general position as that of the foregoing species. It showed little indication of lobing, however, being a flattened, shield-shaped body. Its length was 4.0 mm.; its width was 2.5 mm. at the posterior end but decreased slightly anteriorly.

The data for the pygopodids studied are summarized in Table I. All measurements are in millimeters.

TABLE I. (Pygopodidae)

	Body length	Tip of snout to heart	Tip of snout to thyroid	Maximum length of thyroid	Maximum width of thyroid
Delma fraseri	65.0	16.5	14.5	1.5	1.5
Lialis burtoni	285.0	35.0	32.0	2.0	2.0
Pygopus lepidopus	160.0	24.0	20.0	4.0	2.5

2. AMPHISBAENIDAE

Sub-family: Amphisbaeninae

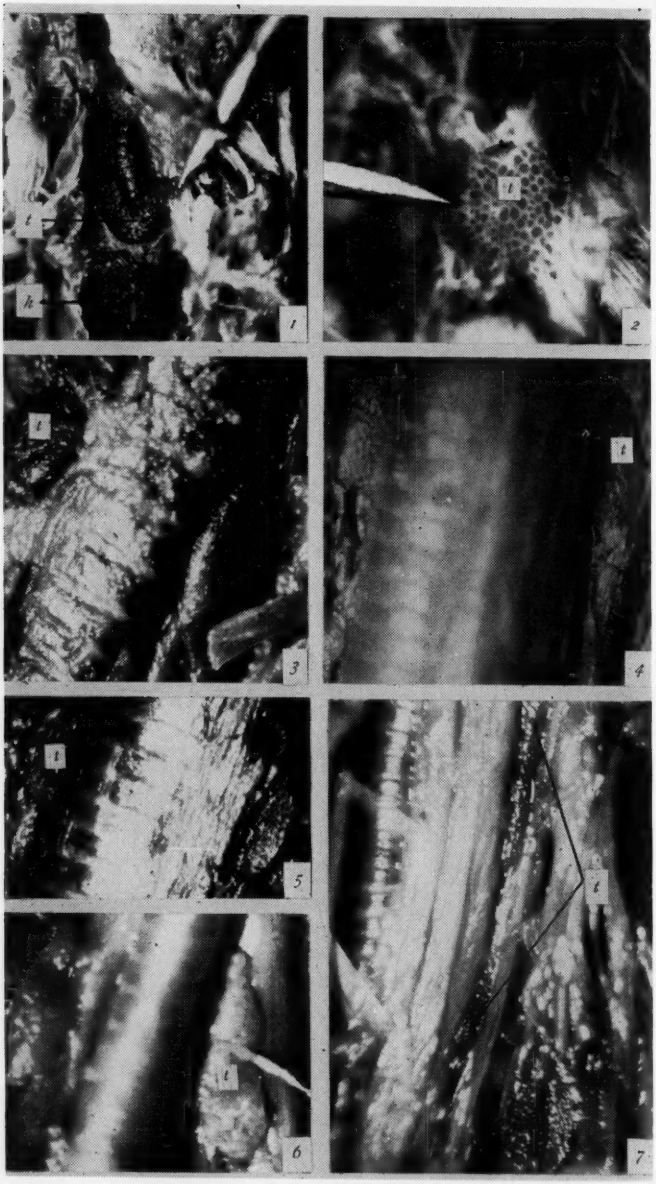
Amphisbaena caeca Cuvier U.S.N.M. No. 129269, Puerto Rico. The thyroid proved to be paired, each gland being a compact ovoid body measuring 1.5 mm. long by 0.7 mm. wide (Fig. 4). The two thyroids were exactly opposite each other, on the two sides of the trachea, and lay at a point 12.0 mm. behind the snout and 40.0 mm. anterior to the heart.

Amphisbaena cubana Peters U.S.N.M. No. 48802, Cuba. This species corresponds with *A. caeca* in having paired ovoid glands.

Amphisbaena darwini Dumeril and Bibron U.S.N.M. No. 65529, Uruguay. The thyroid in this species is paired, but in striking contrast to *A. caeca* and *A. cubana,* each gland is extremely long and thin, extending along the trachea in close proximity to the common carotid artery. The measurements of the two thyroids corresponded closely, each being 9.5 mm. long and 0.3 mm. to 0.5 mm. wide. They extended from a point 13.0 mm. behind the snout to a point 35.0 mm. anterior to the heart. This species is not illustrated but the thyroid resembles that shown for *Leposternon microcephalum* (Fig. 7).

Amphisbaena fuliginosa Linnaeus U.S.N.M. No. 58739, Surinam, S. America. The thyroid of *A. fuliginosa,* like that of *A. darwini,* is paired and elongate. Each gland measured 5.5 mm. by 0.5 mm. Each was situated quite close to the trachea and extended from a point 15.0 mm. behind the snout to 40.0 mm. in front of the heart.

Amphisbaena innocens Weinland U.S.N.M. No. 117251, Haiti. The thyroid is paired and ovoid. In this specimen each gland measured 2.0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mm. by 0.8 mm. and lay about one third of the way back from the snout to the heart.

Amphisbaena manni Barbour U.S.N.M. No. 76656, Haiti. This is another species with paired, ovoid thyroids. Each gland measured 1.2 mm. by 0.6 mm, and was situated at the same general level as in *A. innocens*. (Fig. 5).

Anopsibaena kingii (Bell) U.S.N.M. No. 16619, Argentina. The thyroid of this species is paired and elongate. The left thyroid of the specimen studied measured 7.0 mm. by 1.0 mm. It began 15.0 mm. from the snout and ended 23.0 mm. anterior to the heart. The right thyroid was so thin that it was not identified with certainty in the gross dissection. However, when a strip of tissue taken at the right side of the trachea was sectioned and examined microscopically the thyroid was found. It extended over approximately the same distance as the left gland but at most levels was only one to three follicles wide.

Bipes biporus (Cope) U.S.N.M. No. 21317, Mexico. This proved to be another species with paired compact thyroids. The two glands were opposite each other on either side of the trachea at a level 10.0 mm. behind the snout and 24.0 mm. above the heart (Fig. 6).

Blanus cinereus (Vandelli) U.S.N.M. No. 37234, Portugal. The thyroid of *B. cinereus* is paired and compact. In the specimen dissected, each gland was 2.0 mm. long and 0.5 mm. to 1.0 mm. wide and was situated 10.0 mm. from the snout and 28.0 mm. anterior to the heart.

Cadea blanoides Stejneger U.S.N.M. No. 5729, Cuba. This is another form with paired, ovoid thyroids lying somewhat less than halfway between the tip of the snout and the heart (Fig. 3).

Diplometopon (Pachycalamus) zarudnyi Nikolsky. Two specimens were available for this species, U.S.N.M. Nos. 127998 and 132401, Arabia. In both specimens a single elongate thyroid was found lying slightly to the left of the trachea. Careful search in the course of the gross dissection failed to reveal any indication of a right thyroid, and subsequent examination of sectioned tissue from this area showed no thyroid tissue. In U.S.N.M. No. 127998, body length: 180.9 mm., the thyroid was approximately 10.0 mm. long but extremely attenuated, measuring only about 0.1 mm. in width. U.S.N.M. No. 132401, body length: 149.0 mm., had a thyroid measuring 6.4 mm. by 0.1 mm.

Sub-family: Rhineurinae

Leposternon microcephalum Wagler U.S.N.M. No. 40222, Brazil. The thyroid in this specimen was paired and elongate measuring approximately 25.0 mm. long and varying from 0.2 mm. to 1.0 mm. in width (Fig. 7). The two glands lay directly oposite each other beginning 20.0 mm. from the snout and extending to a point 67.0 mm. in front of the heart.

Monopeltis guentheri Boulenger U.S.N.M. No. 20794, Congo, Africa. The thyroid was paired and with the left gland lying somewhat

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Photographs of thyroid glands *in situ*.
h, heart; t, thyroid

Figs. 1. *Delma fraseri* x 10; 2. *Lialis burtoni* x 10; 3. *Cadea blanoides* x 15; 4. *Amphisbaena caeca* x 13; 5. *Amphisbaena manni* x 13; 6. *Bipes biporus* x 30; 7. *Leposternon microcephalum* x 5.

anterior to the right. The left thyroid measured 4.0 mm. in length, and the right approximately 3.5 mm.

Rhineura floridana (Baird). Two specimens were dissected. Both showed elongate, paired thyroids but differed from the other amphisbaenids studied, except the following, in having a narrow isthmus connecting the posterior ends of the two glands. U.S.N.M. No. 75238, Florida, had thyroids measuring 11.0 mm. by 0.2 mm. They began 11.0 mm. from the snout and terminated about 30.0 mm. above the heart. U.S.N.M. No. 81097, Florida, had glands measuring 13.0 mm. by 0.2 mm. extending from 15.0 mm. behind the snout to 40.0 mm. in front of the heart.

Sub-family: Trogonophinae

Trogonophis wiegmanni Kaup. Two specimens representing this species were dissected. In U.S.N.M. No. 12393, Morocco, Africa, the thyroid was an elongate paired gland measuring 6.0 mm. long and 0.8 mm. wide. In U.S.N.M. No. 58736, Morocco, the form and position of the thyroid was the same as that in the preceding specimen, but the glands were much thinner, measuring only about 0.2 mm. wide by 6.0 mm. long. In both specimens the right and left thyroids were connected at the extreme posterior ends by a narrow isthmus. Sectioning revealed that in the smaller specimen this isthmus had typical follicles, but in the larger specimen the material of the isthmus consisted entirely of connective tissue with no follicles present. Both specimens also possessed a mass of tissue just anterior to the heart which presented the gross appearance of a medial rounded thyroid. Study of serial sections of this tissue revealed, however, that it consisted entirely of adipose tissue.

DISCUSSION

The first pygopodid described was *Pygopus lepidopus* and early ideas concerning the affinities of this species reflect a tendency to lump together all lizards with elongate bodies and reduced limbs. Thus Fitzinger (1826) included *Pygopus* in his family Gymnophthalmoidea and related it to the Amphisbaenoidea and also to the Typhlopoidea, a group now usually assigned to the Ophidia. Wagler (1830), Müller (1831) and Wiegmann (1834) disposed of *Pygopus* in a somewhat similar manner, assigning it to some general group of elongate lizards which included such forms as *Anguis, Bipes, Gymnophthalmus* and *Ablepharus*. Gray (1845) was the first to erect a separate family for *Pygopus,* the Pygopodidae, and he also distinguished two other families, the Lialisidae and the Aprasiadae for the genera *Lialis* and *Aprasia* which he described in this paper. Some later authors, including Hoffman (1890), followed Gray in recognition of these three families, but Cope (1864, 1900), Boulenger (1884), Kinghorn (1926) and most modern authorities include *Pygopus, Lialis, Aprasia,* and several more recently described genera such as *Delma* and *Cryptodelma,* in the single family Pygopodidae. Camp (1923) followed Cope (1900) in concluding that the pygopods represent an ancient derivative of the diploglossid lizards, but recent workers (McDowell and Bogert 1954; Underwood 1957) regard them as more closely allied to the geckos.

In the present study representatives of the three genera *Pygopus,*

Lialis, and *Delma* were dissected. As seen in Table I all agreed closely in having unpaired thyroids situated just above the heart.

It is unfortunate that we were unable to study *Aprasia* which differs from other pygopodids in a number of ways and may merit assignment to a distinct family. So far as the present findings go they probably agree with the idea that *Pygopus, Lialis,* and *Delma* belong to a single natural group although it may be noted that the V-shaped thyroid of *Delma* is rather different from the rounded gland of the other two. In our present state of knowledge the morphology of the thyroid is of little help in indicating the affinities of the Pygopodidae with other lizard families for an unpaired thyroid is found in some members of both the diploglossid and geckonid lizards.

The lizards which are now included in the family Amphisbaenidae have had an even more checkered history, taxonomically speaking, than have the members of the Pygopodidae. Amphisbaenids are wide-spread geographically and, despite their secretive habits, were brought to the notice of zoologists quite early. Laurenti (1768) included them among the snakes, and this was followed by Linnaeus (1788), Lacépède (1790), Merrem (1820), and others. Fitzinger (1826) seems to have been the first to recognize their affinities with lizards, but both Wagler (1830) and Müller (1831) still placed them in the Ophidia. Wiegmann (1834) divided the Sauria into three sub-families: Loricati (crocodiles and alligators), Squamati (lizards), and Annulati. His Annulati contained a single family, the Amphisbaenae made up of seven genera all of which are still included in the amphisbaenids. Gray (1844, 1865) raised the group to the status of a separate order of reptiles containing four families: Trogonophidae, Chirotidae, Amphisbaenidae, and Lepidoshernidae. Hoffman (1890) considered the amphisbaenids as true lizards and therefore reduced them to a tribe, Amphisbaenoidae, under his sub-order Pachyglossae, but retained Gray's four families. Cope (1900) recognized nine suborders of lizards and included the amphisbaenids as well as the Anniellidae in his sub-order Annulati. Camp (1923) distinguished a super-family Amphisbaenioidea with a single family Amphisbaenidae, and concluded that the group belongs to the Scincomorpha, a section of his Autarchoglossa which includes the Xantusiidae, Scincoidea and the Lacertoidea.

In addition to the obscurity concerning the relationships of the amphisbaenids to other lizards, there have also been wide differences of opinion as to interrelationships within this group. In two recent papers the classification of the family has been revised in some detail. Loveridge's (1941) work is limited to the amphisbaenids of Africa, but Vanzolini (1951) considers the family as a whole and his systematic arrangement has been followed in the present study. He recognizes 24 genera of living amphisbaenids and places them in three subfamilies: Amphisbaeninae, Rhineurinae, and Trogonophinae.

The results of the present study of the amphisbaenid thyroid are summarized in Table II where the various genera investigated are arranged in the appropriate subfamilies according to Vanzolini's classification. The first generalization that may be made on the basis of these findings is that the amphisbaenids have a paired thyroid gland. Three possible exceptions

TABLE II. (Amphisbaenidae)

	Body length	Tip of snout to heart	Tip of snout to thyroid	Maximum length of thyroid	Maximum width of thyroid
AMPHISBAENINAE					
Amphisbaena caeca	216.0	54.0	12.0	1.5	0.7
Amphisbaena cubana	172.0	40.0	12.0	1.0	0.7
Amphisbaena darwini	295.0	57.0	13.0	9.5	0.3
Amphisbaena fuliginosa..	218.0	62.0	15.0	5.5	0.5
Amphisbaena innocens ..	213.0	51.0	12.0	2.0	0.8
Amphisbaena manni	215.0	42.0	12.0	1.2	0.6
Anopsibaena kingii	195.0	45.0	15.0	7.0	1.0
Bipes biporus	214.0	35.0	10.0	1.0	0.5
Blanus cinereus	158.0	40.0	10.0	2.0	0.5
Cadea blanoides	260.0	51.0	15.0	2.0	0.7
Diplometopon zarudnyi ..	180.0	37.0	15.0	10.0	0.1
	149.0	35.0	07.0	6.4	0.15
RHINEURINAE					
Leposternon microcephalum	360.0	112.0	20.0	25.0	1.0
Monopeltis guentheri	300.0	95.0	37.0	4.0	0.7
Rhineura floridana	220.0	51.0	11.0	11.0	0.2
	283.0	67.0	15.0	13.0	0.2
TROGONOPHIS					
Trogonophis wiegmanni..	170.0	46.0	16.0	6.0	0.2
	143.0	37.0	17.0	6.0	0.8

to this may be noted in the table. *Rhineura floridana* presents a slight modification in that its two elongate thyroids are connected by a narrow isthmus. Since this condition was found in both specimens dissected, it is probably the normal condition for the species. The two specimens of *Trogonophis wiegmanni* studied showed a similar appearance but histological study proved that in one of these individuals the isthmus consisted entirely of connective tissue. It is, therefore, uncertain whether a thyroid isthmus is characteristic of this species. The third exception is more unusual and somewhat puzzling. Dissection of a specimen of *Diplometopon zarudnyi* revealed a single elongate thyroid lying, not in the mid-line, but on the left side. It was thought that failure to find a right thyroid might be due to faulty dissection or individual variation, and a second specimen was obtained. The same condition was found. The necessity for further study of this species is indicated, but for the present it must be listed as the only amphisbaenid with an unpaired thyroid. It has been noted earlier that the only previous mention of the thyroid gland of amphisbaenids found in the literature is that of Simon (1844) who says simply that the thyroid in these forms "occupies exactly the same site and relations as in the true serpents." Since the thyroid, in all snakes for which this feature has been described, is a single, medial gland, this statement is clearly erroneous.

A second noteworthy generalization to be derived from the examination of Table II concerns the relative position of the thyroid. In the Pygopodidae, considered earlier, and inded in all other lizards studied

(Lynn and Walsh 1957) the thyroid lies in close proximity to the heart, at the lower end of the trachea. In all of the amphisbaenids studied, the gland is situated near the upper end of the trachea and quite widely separated from the heart.

Concerning the shape of the thyroid, the results are difficult to interpret. Most of the species investigated have elongate glands; in some cases it is so attenuated as to present a thread-like appearance. This elongation was found in all the members of the subfamily Rhineurinae and in the single representative of the subfamily Trogonophinae. Among the Amphisbaenidae, however, some members have elongate thyroids (*Amphisbaena darwini, A. fuliginosa, Diplometopon zarudnyi, Anopsibaena kingii*) whereas the others have relatively compact glands in which the length is not more than two or three times the width. As a matter of fact this difference is found even within a single genus (*Amphisbaena*). The two South American species studied (*A. darwini* and *A. fuliginosa*) have elongate glands and the four West Indian forms examined (*A. caeca, A. cubana, A. innoçens,* and *A. manni*) have compact thyroids.

As has been noted earlier, Camp (1923) was inclined to regard the amphisbaenids as early offshoots of the Scincomorpha, thus relating them to the Scincidae, Gerrhosauridae, Lacertidae, and Teiidae. Representatives of all of these families have been studied by Lynn and Walsh (1957) and all prove to have unpaired thyroids. Thus the thyroid morphology, taken by itself, would directly oppose Camp's hypothesis and would indicate that the amphisbaenids have no close affinity with the scincomorphs. It is clear however that much more extensive information is needed concerning the anatomy of the thyroid in other lizard groups before any very definite correlation between thyroid form and inter-familial relations can be expected.

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DEPARTMENT OF BIOLOGY, THE CATHOLIC UNIVERSITY OF AMERICA

EVIDENCE OF OPHIOPHAGY IN THE NIGHT SNAKE.—Stebbins (1954, Amph. Rept. Western N. Amer.: 457) states the following about the spotted night snake, *Hypsiglena torquata:* "It feeds on lizards (*Coleonyx variegatus, Gerrhonotus multicarinatus, Dipsosaurus dorsalis, Uta microscutata,* and others), salamanders (*Batrachoseps*), small toads (*Bufo*), and probably insects. Captive individuals have been maintained on a diet of yucca night lizards (*Xantusia vigilis*) and side-blotched lizards (*U. stansburiana*)."

On April 3, 1957, I collected two 10 and 11 in. *Hypsiglena torquata deserticola* and a 9 in. *Tantilla eiseni transmontana* in Whitewater Canyon, Riverside County, California. All were placed together in a small cylindrical barrel with a tight-fitting cover, from which escape was impossible. On April 5 I collected two more *Hypsiglena* in the same canyon and placed them with the others. The next morning the *Tantilla* was missing. One of the four *Hypsiglena* possessed a prominent ripple in the body, indicating it had eaten the *Tantilla.*

Later, on the night of May 3, a 12 in. *Hypsiglena* devoured a 7 in. *Leptotyphlops h. cahuilae.* Both individuals were from Whitewater Canyon.

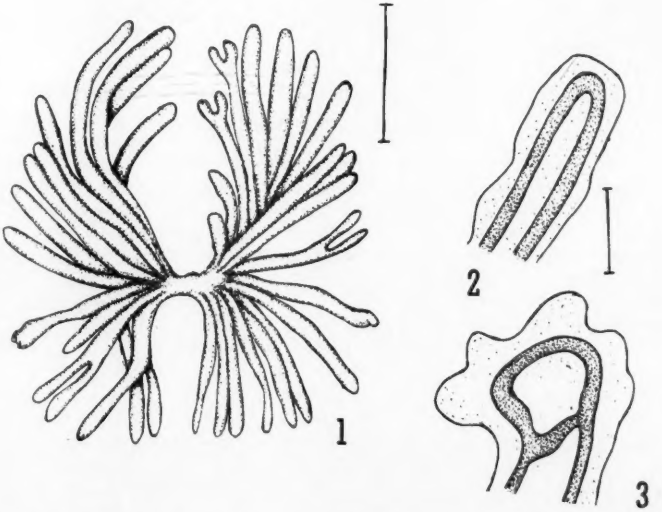
These observations reveal that *Hypsiglena* feeds upon snakes as well as other small vertebrates.—*Ed Kassay, P.O. Box 282, Calimesa, California.*

The Lateral Choroid Plexuses of a Caecilian

By WILLIAM A. HILTON

The brain plexuses of salamanders, frogs and toads have been described in a series of my papers in 1953 (Jour. Comp. Neur., 99: 546-560), 1954 (Herpetologica, 10: 111-113) and 1955 (Fed. Intern. Anat., 6: 103-104). In a number of other papers most of the other main vertebrate groups have been reviewed in connection with these internal brain structures. In some of the very small salamanders and some very small reptiles the lateral brain plexuses were found to be very simple, in fact hardly large enough for more than a simple blood vessel loop. A general conclusion from such forms might suggest that the size and complexity of the lateral plexus of the cerebral hemispheres was somewhat determined by the actual size of the brain.

This may be in large part true, but the caecilian *Chthonerpeton* is exceptional. The specimen examined was 165 mm. long with 199 body segments, head 9 mm. long by 6 mm. wide, and total brain length 6 mm.,



Pl. 1. Lateral choroid plexi in *Chthonerpeton*. The line at the right in each case equals 1 mm. Fig. 1. The choroid plexus of the lateral ventricles spread out flat, the cephalic end at the top. Fig. 2. The end of an enlarged filament with blood vessel loop. Fig. 3. The end of another filament with internal blood vessel loop. This is at the same scale as Fig. 2.

width 3 mm. The cerebral hemispheres were a little more than half the brain length. Spread out flat the two lateral plexuses together were nearly 3 mm. across and their total length about 3 mm. On each side there were 12 to 15 long, slender filaments, some straight, some branched. Their number and position differed on the two sides.

This filamentous condition is entirely different from that occurring in any amphibians I have examined and this includes many genera and species. In the limited figures of caecilian brains in the literature, fragments of the plexus are shown in the cavities of the cerebrum which indicate a plexus of many cylindrical filaments. The general form of this plexus is more like structures found in reptiles and some birds. Each filament contains rather wide blood vessels which form more or less of a simple loop at the end, or in some cases cross connections below the tip of the filament. (Figs. 2, 3.)

The general conclusions from this preliminary study are as follows: (1) in *Chthonerpeton* the choroid plexus of the lateral ventricles of the brain are more of the reptilian than the amphibian type; (2) in this form, at least, simplicity of choroid structure does not go along with a small brain; (3) the slender filaments, more or less cylindrical, are numerous but not symmetrical in either number or form on the two sides; and (4) simple capillary loops penetrate each villus-like filament.

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A Simple Trap for Collecting Desert Reptiles

By BENJAMIN H. BANTA

Techniques for trapping reptiles have been employed for collecting by Rodgers (Copeia, 1939: 51) and Vogt (Copeia, 1941, 115), and for ecological studies by Fitch (1951, Herpetologica, 7: 77-80; 1954, Univ. Kans. Publ. Mus. Nat. Hist., 8). Usually a great deal of ingenuity and elaborate construction has gone into such traps. Entomologists (Oman and Cushman, 1946, Misc. Publ. U.S. Dept. Agr., 601) have long employed the method of burying jars and tinned cans in the ground as pitfalls for the collection of ground beetles and other surface-crawling insects. It was thought that perhaps such a method could be successfully used for trapping reptiles, at least the smaller species.

During the spring of 1953, while collecting amphibians and reptiles along the west side of the Colorado River opposite Fort Mohave (Arizona) in Clark County, Nevada, an attempt was made to use buried one-gallon wide-mouthed jars as pit-fall traps for collecting reptile specimens. The jars were buried so that the opening was flush with the surface. Rocks or boards, depending upon their availability, were then placed over the mouth so that several small openings were left for the entrance of small animals seeking shelter or escape under the rocks or boards (Fig. 1). A total of six jars were so buried, approximately 15 yards apart; all were located in the same large sandy wash. A six-day period was spent at this one place. The buried jars were checked usually during the evening when the high air temperatures were declining. For the first three days no

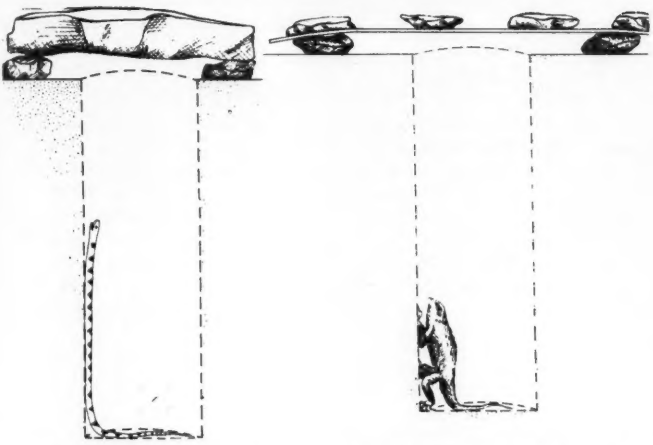

Fig. 1. Lateral section diagram of buried five-quart can with boulder cover and trapped shovel-nosed snake, *Chionactis occipitalis.*

Fig. 2. Lateral section diagram of buried five-quart can with disassembled cardboard carton cover and trapped desert scaly lizard, *Sceloporus magister.*

reptiles were found in any of the traps. On the fourth and fifth days the traps were not checked. On the last, the sixth, day the traps were visited and at that time all but one jar contained a live lizard. Three jars each had an adult *Uta stansburiana stejnegeri* Schmidt, and two each had one adult *Cnemidophorus tigris tigris* Baird and Girard.

No attempt was made to utilize this technique again until May of 1955 when jars were buried on a relatively large scale for collecting reptile specimens in southern and western Nevada.

It was soon found that gallon jars break readily under rugged field conditions, and it immediately became necessary to utilize other sturdier types of containers. The types ultimately used were the following:

1. One-gallon tinned can ("10")—commonly used for fruits, vegetables, etc., for restaurants. Height: 190 mm.; inside diameter: 66 mm.; ratio of height to diameter: approximately 3:1.
2. Five-quart tinned can—commonly used for motor oil by some of the nation's major oil companies. Height: 240 mm.; inside diameter: 66 mm.; ratio of height to diameter: 3.5:1.
3. Five-gallon metal pail—commonly used for paints, grease, etc. Height: 338 mm.; inside diameter: 286 mm.; ratio of height to diameter: 1.2:1.

Of the above three types, the five-quart can proved by far the most successful for trapping reptiles. Apparently the first and third were generally not deep enough (the ratio of height to diameter was insufficient) to prevent the escape of any but the smallest species. All the cans

used were either picked up at municipal garbage dumps, or from service stations or restaurants at no cost.

It was found that the newer, smooth-sided cans were much more effective than cans whose inside surface was rough with rust.

At first small boulders were used to cover the traps (Fig. 1), but it was later found that disassembled cardboard cartons could be used with even greater success (Fig. 2). In using disassembled corrugated cardboard cartons, the buried cans seemed to have been better insulated from the hot desert sun. Apparently the temperatures within the cans did not become too high and the reptiles trapped were not subjeced to excessively high temperatures as was true when boulders were employed. To prevent the cardboard from being blown away by winds (usually present in desert areas), small stones, sticks, and gravel were placed upon the cardboard, usually near the edges and corners.

Although no concerted attempt was made to trap amphibians, two species, *Bufo boreas boreas* and *Bufo punctatus,* were discovered in buried cans.

To demonstrate the versatility of this method, the following list of reptile species collected is of interest: *Coleonyx variegatus, Disposaurus dorsalis, Crotaphytus wislizeni, Sauromalus obesus, Callisaurus draconoides, Sceloporus magister, Sceloporus occidentalis, Sceloporus graciosus, Uta stansburiana, Urosaurus ornatus, Xantusia vigilis, Cnemidophorus tigris, Eumeces gilberti, Phyllorhynchus decurtatus, Sonora semiannulata, Chionactis occipitalis.*

From the above list it will be noted that most of the lizard species inhabiting areas in which traps were used were captured by this method with the notable exceptions of *Crotaphytus collaris* and *Phrynosoma platyrhinos.* Only a few specimens of the snakes listed were caught in the traps; lizards comprised the majority.

Small mammals such as *Citellus leucurus* and *Peromyscus* spp. were frequently collected, but in most instances were dead when the trap was inspected. Often a large number of beetls, especially tenebrionids, as well as various species of scorpions, was found in the cans.

This trapping method does have its disadvantages. It involves equipment which takes much space, namely the cans or jars, and it does require a lot of work to dig the holes for the cans or jars. There were many occasions when the expected results did not materialize; however, there were instances when as many as seven specimens of one species were secured in one can (*e.g., Sceloporus graciosus* in the Charleston [Spring] Mountains, Clark County, Nevada), and at one trapping station as many as five species (11 specimens) were found in the same can over a period of three weeks (*e.g., Coleonyx variegatus, Dipsosaurus dorsalis, Sceloporus magister, Uta stansburiana,* and *Cnemidophorus tigris,* all at Station No. 7 near Davis Dam, Clark County, Nevada).

This method when used in conjunction with other present-day techniques does help to assure a more adequate sampling of the reptile fauna of a given geographic area.

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Some Microscopic Aspects of Ecdysis in Snakes

By H. Bernard Bechtel

The brief study presented here was undertaken for the purpose of correlating the microscopic changes in the skin of a snake with the gross appearance of the snake at intervals throughout the casting cycle. Within a few hours after an adult *Elaphe guttata guttata* had cast, a small biopsy was removed from one of the ventral plates. Similar biopsies were removed from nearby ventrals every four days until the next cast. The biopsies were stained with hematoxylin and eosin, examined microscopically, compared with one another, and correlated with the appearance of the snake at the time the biopsy was taken. In order to confirm the particular series of events seen in the first cycle another similar series of biopsies was removed from the same snake between two subsequent castings. A third similar series of biopsies was removed from an adult *Pituophis catenifer sayi*. This snake was chosen because it was of a different genus and it generally had a longer casting cycle than the *Elaphe* used in the other series.

The following description is of the *Elaphe* between Aug. 26, 1956, when the snake cast, and Oct. 2, 1956, when the next casting occurred. Immediately after casting the snake's color was at maximum brilliance and sheen. The color remained bright for about a week and then became progressively duller until Sept. 19, by which time the pattern was relativeley obscure. On Sept. 24 the snake first displayed the typical milky or cloudy coloration which precedes casting. This cloudiness cleared rather suddenly on Sept. 30 and the snake became bright in coloration until Oct. 2, when casting occurred. These are the typical changes, familiar to every herpetologist, and are mentioned here for reference when the microscopic sections are described.

As the snake was undergoing these changes between one cast and the next, the cells of the epidermis were undergoing some equally remarkable changes. Fig. 1 shows the Aug. 26 biopsy, removed shortly after the snake had cast. At this time the epidermis was thin; it consisted of about three layers of cells surmounted by a thin layer of keratin, and the basal layer of epidermal cells was in orderly columnar arrangement. Fig. 2 is of the biopsy taken Aug. 30, four days after the snake had cast. At this time the basal layer of epidermal cells was undergoing, or had undergone, marked proliferation, with the overlying cells being essentially the same as before. Since all of the illustrations are at the same magnification, it can be seen that epidermis from this stage on is considerably thicker than it was immediately after casting. The next three biopsies, removed Sept. 4, 9, and 13, showed little or no cell formation in the epidermis, but the many new cells formed shortly after the cast assumed a more orderly arrangement. In these three sections, aside from the fact that the epidermis was thicker and contained more cells, the general configuration was about the same as in Fig. 1. Fig. 3 is of the sixth biopsy, taken Sept. 19, when the colors of the snake were becoming obscure but the cloudy phase had not begun. At this time decided changes had occurred in the cells of the epidermis, and some new cells had made their appearance in the dermis.

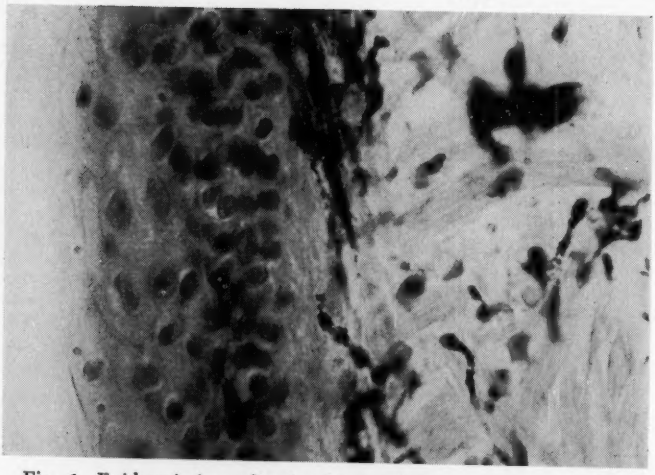

Fig. 1. Epidermis immediately after casting.

Fig. 2. Epidermis four days after casting. Basal layer proliferating.

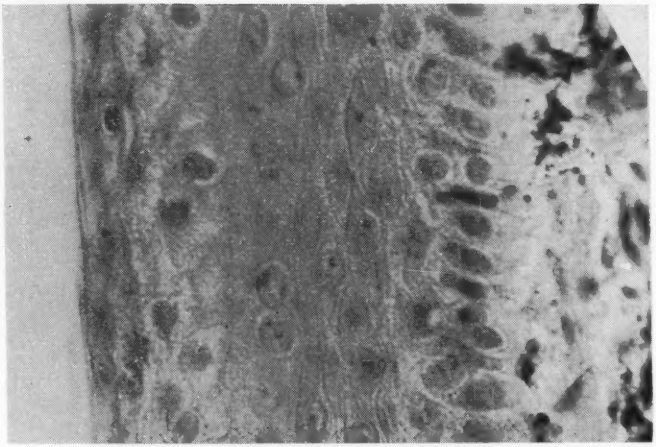

Fig. 3. Epidermis just before cloudy phase begins.

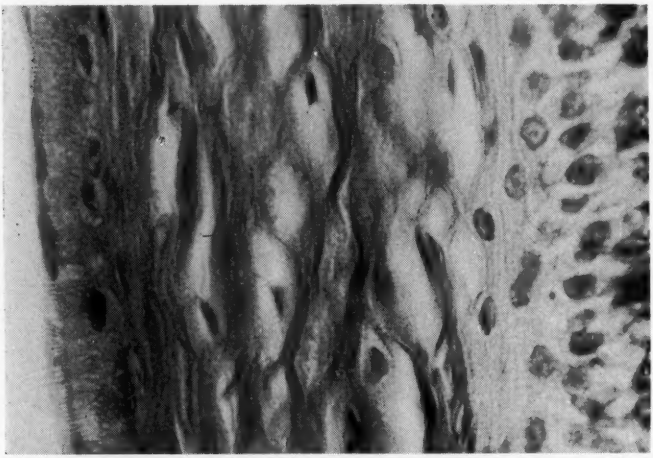

Fig. 4. Epidermis immediately after cloudy phase begins. Cells undergoing keratinization.

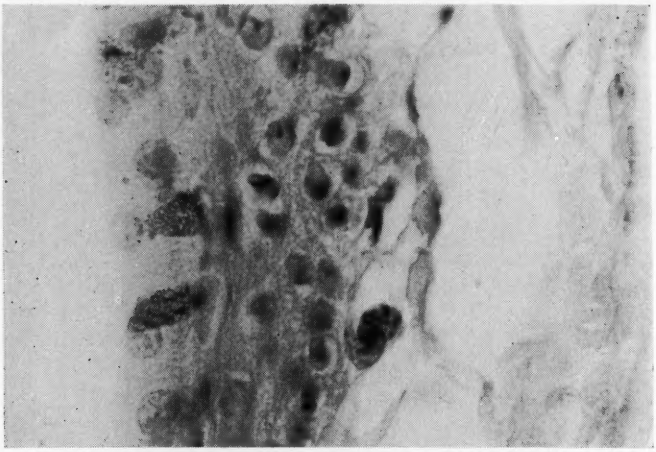

Fig. 5. Eosinophils in epidermis on side of ventral away from crawling surface.

In the epidermis, except for the basal layer and a few cells directly above this layer, all the cells had become swollen, their nuclei enlarged, and the cytoplasm more granular. In this section were seen, for the first time, occasional eosinophils in the upper dermis and the lower epidermis. They were oval cells with eccentric nuclei, filled with eosinophilic-staining granules, and larger than epidermal cells. These eosinophils were present, furthermore, only on the side of the ventral plate next to the snake's body. Fig. 4 is of the seventh biopsy, taken Sept. 24, the first day the snake had entered the cloudy phase. At this time the entire outer two thirds of the epidermis was undergoing simultaneous keratinization, with the cells losing their outlines and taking on the staining characteristics of keratin. In this section the previously-mentioned eosinophils were extremely abundant, and most of them were found well up into the epidermis. Fig. 5 shows the eosinophils, on the side of the ventral next to the snake's body, again from the biopsy removed Sept. 24. The eighth biopsy was removed Sept. 29, while the snake was still very cloudy, and the slough was lost in the fixing fluid. Microscopically this biopsy was almost indistinguishable from the one removed immediately after casting, except for a few lingering eosinophils. The snake cast before time for another biopsy.

The second series taken from the same snake proved to be a repetition of the first. The series taken from the *Pituophis* was also basically the same as both series from the *Elaphe*. In *Pituophis* the proliferation of the basal layer again took place within four days after the snake had cast, and the eosinophils appeared at about the time the epidermal cells were turning to keratin, again being present only on the side of the ventral plate away from the crawling surface.

These observations were undertaken to answer some questions about ecdysis in snakes, but they created more new questions than they answered. In a general way the microscopic changes were about what one would expect: the epidermal cells divide to form new ones, the cells undergo a process of keratinization, and the newly-formed keratin is sloughed. But many of the details of this general process were exceptionally interesting and surprising. When I began I had the impression that milky fluid appeared between the snake and the about-to-be-cast skin, and that this fluid suddenly cleared before the casting date. The microscope does not bear this out in the series presented, as there is no layer of fluid when the snake becomes cloudy. There may be something homologous here to the human fingernail, which is also made of keratin. The base of the nail (the lunula), where keratin is being formed, is cloudy or milky in color. The bulk of the fingernail, made of fully formed keratin, is transparent and pink, due to the underlying capillary bed showing through. Similarly the snake's pigment shows through after the keratin is fully matured, accounting for the relatively bright colors of a snake immediately before casting. The proliferation of the basal epidermal cells was to be expected, but the fact that this proliferation came suddenly was somewhat of a surprise. Equally interesting was the fact that the epidermis underwent keratinization suddenly shortly before casting, rather than this process taking place gradually throughout the time between casts. Discovery of eosinophils in the snake's skin was perhaps the most intriguing of all, not because they were present at all but because they were consistently seen only on one side of the ventral plate. This phenomenon was borne out in the series taken from both genera. Zimmerman and Pope (1948, Fieldiana: Zool., 32:394) suggest that these eosinophils are concerned with degenerative processes within the stratum intermedium of the epidermis, and that they exert some controlling influence in the zone of intraepithelial delamination. Their sudden appearance in the dermis towards the end of the casting cycle and their migration up into the epidermis as the cells are undergoing keratinization certainly indicate that their presence and location are of great significance. If they do play some role in the separation of the slough there may be good physiologic and anatomic reasons for the separation of the actual crawling surface last, accounting for their presence only on the side of the ventral plate away from the crawling surface. Actually, one of the striking things about each cellular process and change, from one cast to the next, is the apparent orderliness and timing of each event. There is certainly not just one gradual continuous change.

The trauma of the biopsies, incidentally, had no noticeable effect on the time between subsquent casting, nor did it affect the demeanor of the snakes being used. Both snakes fed uninterruptedly, often feeding immediately after the biopsy was removed.

3359 MEADOW CT., INDIANAPOLIS 5, INDIANA

Discovery of the Frog *Cornufer guentheri* on Negros Island, Philippines, with Observations on Its Life History

By ANGEL C. ALCALA and WALTER C. BROWN

Inger (1954, p. 365) notes that examples of the population of *Cornufer guentheri* Boulenger from the northern islands of Luzon and Polillo exhibit a more extensive webbing between the toes and a somewhat more rounded snout than do examples of the population from the southeastern islands of Leyte, Dinagat and Mindanao. Another population of this species was recently discovered by the senior author in the mountains of southwestern Negros Occidental. The five mature or nearly mature specimens (Stanford University 17999-18003) which were obtained appear, as far as the above mentioned characters are concerned, to have much closer affinities with the Luzon-Polillo populations. All five specimens were obtained from epiphytic plants growing on trees in the original diptocarp forest.

Of even greater interest, however, was the finding of the unhatched embryos of this species (Stanford University 17996-17998), also among the moist roots of an epiphytic fern attached to the limb of a tree about 35 feet above the ground. The initial discovery of the fact that *C. guentheri* lays eggs on land and undergoes direct development was made by Dr. Edward H. Taylor and reported by Noble (1925, p. 5; 1927, p. 108; 1931, p. 64). These, however, were all apparently in an advanced stage of development, as Noble discusses only characteristics of the recently hatched or about-to-be hatched individuals. Noble calls special attention to similarities of the hatchlings of *Cornufer guentheri* to the hatchlings of *Discodeles opisthodon* from the Solomon Islands. The latter also undergoes direct development as reported by Boulenger (1886, p. 51). These specimens, collected by Mr. Guppy, were also at an advanced stage of development. Boulenger simply notes that there was no evidence of tail or gills but that an arrangement of transverse folds on the sides of the abdomen might be respiratory in function (see Noble, 1927, p. 109, fig. 28). Noble (op. cit.) called attention to the similarity of this feature as exhibited by *C. guentheri* and also the lack of a tail or gill structures in the late stages of development as evidenced by the material available to him. He also noted (1925, p. 5), based on histological evidence, that these folds in *C. guentheri* probably have little or no respiratory function and surmises that they are a transitory result of a rapid absorption of the yolk.

The embryos previously mentioned were taken May 29, 1956, at Sitio Dungga, about 16 km. S. of Barrio Toyum, Cauayan, Negros Occidental. The froglets were encased in tri-layered gelatinous capsules, 7 to 8 mm. in diameter. One hatched five days later, one seven days later, and the third failed to survive transit and was preserved unhatched. The two hatchlings measured approximately 7 mm. snout-vent. The loose fold of skin on either side of the abdomen, forming a "V" posteriorly, appears as illustrated by Noble (1927, p. 109, fig. 28). An egg-tooth, such as

that exhibited by hatchlings of *Discodeles opisthodon,* is not evident in either the hatched or unhatched examples.

Direct development for this species, assuming that the single, unhatched specimen exhibits a normal pattern, appears to have attained certain shortcuts not otherwise positively known for any of the anurans undergoing direct development. These are failure to develop any evidence of a tail and the precocious development of the head and forelimbs (Fig. 1). In other aspects of abbreviation, as the presumed extent of suppression of the larval mouth parts and all evidence of gills, the pattern is analogous to that exhibited by some species of *Eleutherodactylus* (in the Bufonidae) such as *nubicola* and *geuntheri* (see Lynn, 1942 and 1946; Lutz, 1946; and Orton, 1949).

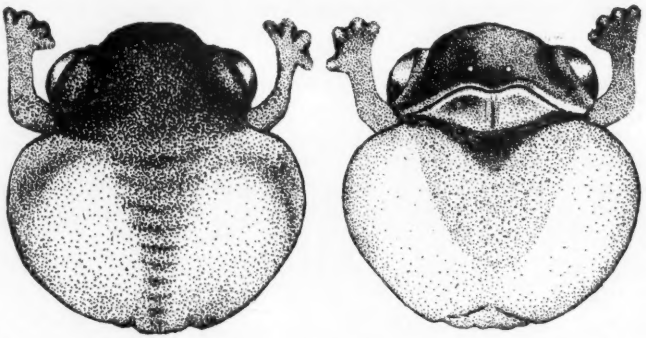

Fig. 1. Dorsal and ventral views of young of *Cornufer guentheri* presumabably about seven days before hatching, showing precocious development of head and fore limbs.

The abbreviated pattern of development exhibited by this species of *Cornufer,* whatever its adaptive significance, as compared with some other members of the Ranidae in the Oriental-Papuan region, is unique only in the extent to which certain stages are passed through very quickly or omitted entirely. Other genera of Ranidae, for example *Discodeles* and *Ceratobatrachus,* are known to omit or are suspected of omitting the aquatic larval stage. Even members of the *Rana (microdisca* and *macrodon*), at least some subspecies, lay the eggs on land in a manner like some of the rhacophorids and the larvae must find their way to water after hatching (see Alcala and Brown, 1956).

Within the genus *Cornufer,* as now generally recognized, however, it is interesting to note how much more abbreviated is the developmental pattern in *guentheri* than in *Cornufer pelewensis* from the Palau Islands. This species has its closest affinities with *C. papuensis* of New Guinea and the Solomon Islands. The developmental pattern exhibited by *C. pelewensis* was reported by Atoda (1950). In this species the larval mouth parts are suppressed, but a relatively long, normal appearing larval tail is present; the hind limbs develop slightly more rapidly than the

fore limbs and an expansion of the abdominal skin in the form of two large vascularized pouches beyond the limits of the yolk is evident. These, Atoda suggests, may serve a respiratory function.

When more information is available on the developmental patterns exhibited by the various "papuan" and "oriental" species presently referred to *Cornufer,* it may be possible to determine evolutionary lines and to judge with greater assurance the significance of morphological characteristics which have at times been used as a basis for recognizing a group of species for which the name *Platymantis* has been used as distinct from *Cornufer* (*sensu strictu*). *C. guentheri* belongs to the latter; *C. pelewensis* belongs to the *Platymantis* group.

ACKNOWLEDGEMENTS—This study forms a part of a research program concerned with herpetofaunas of the Philippine Islands. This program was begun while the junior author was a lecturer at Silliman University and is being completed under the auspices of a grant from the National Science Foundation. Illustrations were prepared by Mr. Walter Zawoski, Stanford Research Institute.

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NOTES ON METAMORPHIC AND BREEDING AGGREGATIONS OF THE EASTERN SPADEFOOT, *SCAPHIOPUS HOLBROOKI* (HARLAN).—In a series of papers, Arthur N. Bragg has discussed the behavior of Hurter's spadefoot, *Scaphiopus hurteri* Strecker, with special reference to aggregation and mass movement of recently transformed individuals. Bragg (1950, Proc. Okla. Acad. Sci., 31: 26-27) thought that such movement was characteristic only of *S. hurteri,* and stated, "This phenomenon has never been described for other species . . . although one might, perhaps, expect it in the closely related *S. h. holbrookii* . . ." (p. 27). Bragg (1954, Herpetologica, 10 (2): 102) said of metamorphic aggregation in *S. hurteri,* "Nothing like it has ever been described in any other species [of this genus]."

As a matter of fact, in the eastern spadefoot, *Scaphiopus holbrooki* (Harlan), there may be a mass movement of newly transformed individuals. Mary C. Dickerson (1906, The Frog Book: 56) remarked of this species, "One observer records an exodus of thousands of young spadefoot toads from their native pond. For hours they 'trudged' in leisurely fashion up a steep hill, apparently not stopping for food on their way." Dickerson may have had reference to the observations of Nicholas Pike (1886, Bull. Amer. Mus. Nat. Hist., 1 (7): 213-221). Pike witnessed movement en masse of newly transformed *S. holbrooki,* and commented, "It is evident they go far from their watery home, for they were marching steadily on, the column spreading out about fifty feet wide with none beyond it. I saw an immense number of very small crickets in among them, but . . . I could not see any of the little Spadefoots eating them." (p. 218). Charles C. Abbott (1904, Proc. Amer. Phil. Soc., 43: 163-164) thought that vast numbers of young *S. holbrooki,* wandering from the vicinity of a breeding pond after a hard rain, accounted for supposed "showers of toads." Abbott did not believe that the exodus necessarily took place immediately after metamorphosis. According to his view, the toadlets might remain concealed for some time near the pond in which they had developed, emigrating only after a rain. A. H. Wright (1932, Life-Histories of the Frogs of Okefinokee Swamp, Georgia: 83, 104) quoted some of the earlier records of metamorphic aggregation and movement in this species. Ross Allen (1941, All-Pets Magazine: unpaged reprint) described a metamorphic migration of *S. holbrooki* at Silver Springs, Marion County, Florida. He stated, "One morning about seven-thirty, in the spring of 1932 . . . I noticed that the curbstone . . . in front of my home was lined with a black moving mass . . . I found it to be thousands of day-old baby Spadefoot Toads (*Scaphiopus holbrookii holbrookii*). The gutter was piled three inches deep with them for a distance of about 150 feet . . . Some of the baby toads caught underneath the mass were smashed to death [and] hundreds had been killed by cars during the night . . . The tiny black toads were hardly three-eighths of an inch long. Evidence of the tadpole tail was just disappearing. Watching them, I was amazed at their determination to get over the curbing, driven by the instinct to migrate from the pond from which they had hatched . . ."

In 1950 I observed a movement of newly transformed *Scaphiopus holbrooki* across the Old Silver Springs Road in Ocala, Marion County,

Florida. This was about 7:00 a.m. There was a light drizzle at the time. Hundreds of the toadlets had been killed by passing automobiles, and a pungent odor emanated from the crushed bodies. (Apparently the odor is produced by skin secretions.) Numerous mockingbirds and blue jays were hopping on the road, eyeing the amphibians. Although I watched closely, I did not see a bird peck at or try to eat one of the little toads. The general area was covered with mesic woods, broken here and there by suburban residences, lawns and artificial clearings. About 100 feet from the road, in a hollow, was a rainwater pond from which the toads must have come. They seemed to be heading toward a dense mesic wood on the opposite side of the road. At this spot the curbing was not continuous, and I suspect that many of the toads had crossed the road before I arrived.

Another migration of *Scaphiopus* toadlets was observed on June 7, 1957, by Eugene T. Smith and myself, near New Smyrna Beach, Brevard County, Florida. The little anurans were crossing State Highway 40, coming from a cypress pond on one side of the road and moving into a plant nursery on the other side. Heavy traffic had decimated them, and the survivors were more widely scattered than is usual in such aggregations. Nevertheless they were all moving in the same direction. Efforts to "herd" some individuals back toward the pond were unsuccessful; they would only circle and continue in the original direction. This migration was encountered about 7:00 p.m., shortly before dark. Rain had fallen off and on during the day.

Between 1935 and 1940, and again between 1945 and 1949, I saw several migrations of newly transformed *Scaphiopus* near DeBruce, Richmond County, Georgia. These were noted in the early morning when the ground was damp. The moving mass of toadlets usually covered two or three square yards of substratum. These aggregations always included a few newly transformed individuals of the ornate chorus frog, *Pseudacris ornata* (Holbrook). The young chorus frogs were easily located in the moving mass, for, unlike the dusky toads, they were bright green with darker green markings. (This is a metachromatic phase just occasionally assumed by adults of *P. ornata.*) An aggregation, encountered 235 yards from water, included three ornate chorus frogs among an estimated 1980 spadefoot toads. The presence of *P. ornata* in these aggregations is clearly not fortuitous.

Depending upon weather conditions, *Pseudacris ornata* may breed at any time from December through April, and *Scaphiopus holbrooki* at any time from March until the advent of cool weather in the fall. The spadefoot breeds in deep rainwater ponds, the chorus frog in shallow, transient ones or in the deeper ones. Consequently, larvae of *P. ornata* must often transform in company with those of *S. holbrooki.* It would be interesting to learn whether newly transformed individuals of Strecker's chorus frog, *P. streckeri* Wright and Wright, may in similar fashion accompany the young individuals of *S. hurteri* in the latter's metamorphic aggregations. Strecker's chorus frog and Hurter's spadefoot are known to breed in the same pond and at the same time (Jameson, 1950, Copeia, 1: 61).

Bragg (1944, Amer. Nat., 79 (780): 54) stated that, in the genus *Scaphiopus,* the breeding calls of the males attract not only the females but also other males. Observations bearing out this contention have seldom

been published, at least in the case of *S. holbrooki*. Two experiences with this spadefoot are therefore of interest. On one occasion near Bascom, Screven County, Georgia, there was a heavy rain during the day, and in the late evening spadefoot toads began to call from a cypress pond. A small chorus developed before it was completely dark, and I saw several other individuals of this species on a sand road and in sandy patches near the pond. The belated ones were hopping toward the pond, halting when the chorus died down and advancing when it began again. I derived an impression that the late comers were guided by the calls from the pond. Three of the toads, hopping toward the pond, were collected; they were males.

The other experience took place about three miles west of Augusta, Richmond County, Georgia. At this locality, spadefoot toads often bred in a transient pond bordered by low, sandy hills. One morning workmen dug a ditch on the top of a hill overlooking the pond. This ditch was about eight feet long, two feet wide and three feet deep. That afternoon a hard rain fell, and I visited the locality about 9:00 p.m. that night. There were six or eight inches of water in the ditch, and here the spadefoot toads had congregated. There were about a dozen calling males and two amplexating pairs in the ditch, but not a spadefoot in the pond. Geopositive, rheopositive and hygropositive reactions, all of which might conceivably lead a toad to water, would in this case have led it to the pond and not to the little ditch atop the hill. It is likely that one of the males, among the first to emerge from its burrow after the rain, fell into the ditch and began calling, thus attracting others.

Bragg (*ibid.*: 57) stated that there was no case, so far as he could determine, of *Scaphiopus holbrooki* breeding in daylight. Actually, many such cases have been reported. J. A. Allen (1868, Proc. Boston Soc. Nat. Hist., 12: 186-187) found amplexating pairs during the day, and heard choruses from 1:00 p.m. until 3:00 a.m.. F. S. Smith (1879, Amer. Nat., 13 (10): 651-652) encountered a large breeding chorus in the morning, and another on the afternoon of the succeeding day; both sexes were present in the aggregation. C. W. Hargitt (1888, *ibid.*, 22 (258): 535-537) investigated a large, vigorous chorus about 4:00 p.m.; he found spadefoot eggs in the water. Frank Overton (1914, Mus. Brooklyn Inst. Arts and Sciences, Sci. Bull., 2 (3): 28-30) reported a chorus that lasted all day. John T. Nichols (1917, Copeia, 45: 59-60) mentioned choruses in the morning and in the afternoon. Andrew Nichols (1852, Jour. Essex County Nat. Hist. Soc., 3: 113-117) heard a chorus that continued for "one or two days and nights," and another on a dark and rainy forenoon. C. C. Abbott (1884, Amer. Nat., 18 (11): 1075-1080) heard a prolonged chorus that was more vigorous by day than by night. Francis Harper (1928, Bull. Boston Soc. Nat. Hist., 46: 3-9) investigated a spadefoot chorus in midafternoon. Some of the earlier accounts of diurnal breeding by this species were mentioned by Wright (*op. cit.*). It is true, however, that nocturnal choruses are much more common than diurnal ones, at least in South Carolina, Georgia and Florida, where I have studied the species.—Wilfred T. Neill, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

THE RANGE OF *CROCODYLUS ACUTUS* ALONG THE FLORIDA GULF COAST.—Few records of the occurrence of *Crocodylus acutus* Cuvier in areas north of the Everglades National Park have ever been published. In fact current works commonly give the North American distribution as the "extreme southern tip of Florida." Carr and Goin (1955, Repts., Amphs., Fishes Fla., 252) mention that the range is "now much reduced" and may one time have extended as far north as southern Collier County. Previously Moore (Copeia, 1953: 55) stated: "Apparently there is no evidence that it occurs naturally anywhere on the Florida west coast."

On the contrary, evidence does exist that the crocodile exists even at the present time at least 140 miles north of the commonly accepted limits in and south of the Everglades National Park.

Hearsay reports of *C. acutus* are numerous along the Gulf Coast of Southern Florida. Recently commercial fishermen and guide-boat captains have related to the writer that they have observed *C. acutus* in the area of the Ten Thousand Islands, Cocohatchee Creek, and brackish inland waters adjacent to Marco Island, all of which lie in or south of Collier County. Farther northward in the area of Charlotte Harbor, Charlotte and Lee Counties, there have been reports by fishermen and a few uninterested observers. Dr. Eugenie Clark of the Cape Haze Marine Laboratory, Placida, Florida, informed the writer that a previous employee of the Laboratory observed *C. acutus* in the area.

On another occasion (approximately 1920) an alleged crocodile was killed near Venice, Sarasota County, by workers who were constructing a railroad grade through mangrove swamps.

Three reports not open to question of identity have been provided by the writer's former employers, Lester and Wilford Piper of the Everglades Wonder Gardens, Bonita Springs, Florida. These men maintain the largest collection of Florida specimens of *C. acutus* in existence: a total of about 50 adults and twice that number of juveniles. The present adults were captured between the late 1930's and the fall of 1953. Most came from the vicinity of Key Largo, Monroe County, and others from the Cape Sable region.

As related by the Pipers, in 1930 they examined an adult *C. acutus* killed by a fisherman-alligator hunter in the Imperial River, Lee County, Florida. In the fall of 1953 an 8-foot female crocodile was reported swimming amidst fishing boats and bathers near Sarasota, Sarasota County, The specimen was captured in the Gulf at Osprey, Sarasota County, and is alive at present in Piper's collection.

It is impossible to know how many of the records here summarized are in error or are based upon escapees. In every case, however, the reports are credible at least on the basis of habitat, for they involve mangrove estuaries and shallow, tidal marshes such as are commonly inhabited by the species in the Everglades. Apparently suitable habitats are available along much of the southern Gulf Coast, northward at least to Sarasota Bay, and it is probable that the species occurs at least sparsely throughout this area. It is possible that, with the protection now afforded by state and federal laws, the population will increase in density in these peripheral areas.—*Charles R. LeBuff, Jr., 1025 8th Avenue North, Naples, Florida.*

Some Factors in the Feeding of Toads

By ARTHUR N. BRAGG

For most of the last 20 years I have kept toads in captivity to observe their reactions and have also taken extensive notes on behavior while in the field at night. An earlier paper (Smith and Bragg, 1949, Ecology, 30: 333-349) emphasizes what food toads of the genus *Bufo* in Oklahoma are known to have eaten, but little is reported concerning the selectivity of individuals or their reactions at different ages. This paper supplements the earlier one on *Bufo* and adds observations on three species of *Scaphiopus*.

I have watched closely as toads fed under many conditions and now generalize from extensive notes for the following species: *Bufo cognatus* Say, *B. terrestris charlesmithi* Bragg, *B. compactilis speciosus* Baird, *B. debilis debilis* Girard, *B. woodhousei woodhousei* Girard, an intergrade between *B. w. woodhousei* and *B. w. velatus* Bragg and Sanders, *Scaphiopus bombifrons* (Cope), *S. couchi* Baird and *S. holbrooki hurteri* Strecker. At various times I have had mixtures of these species together, although seldom all of them at one time. They were of many sizes and ages between recently metamorphosed juveniles a few millimeters in length and large adults, some of known age, including both sexes, in most possible combinations. At various times I have also maintained separate groups of a single species or of a given age, sometimes made up of field-collected specimens, at others of individuals reared from tadpoles. Field observations have been mostly beneath street lights at all times of night, supplemented by flashlight observations along roadways. Captive toads have also been watched under artificial lights which were placed above their confines to attract insects. I have no reason to think that the presence of electric lights has any influence upon toad feeding except that of availability of food. Temperature, humidity, and seasonal factors variously influence the abundance and kinds of insects attracted and this obviously limits selectivity on the part of confined toads. Among the species mentioned I have had least experience with *B. punctatus, B. d. debilis* and *S. couchi.* Also, almost all of the *S. h. hurteri* confined have been males or small juveniles of unknown sex.

Movement as an attractant: It is a common statement that toads strike only at moving objects and the usual inference is that anything small enough that moves may be attacked. If this were strictly true, small toads confined with large ones would not last long. I have never known a small toad to be attacked by a larger one whether of the same or different species even when the smaller is no larger than acceptable beetles. Movements of small objects attract the attention of toads, but they normally react only to certain types of movement. A June beetle on its back waving its legs in its attempt to right itself is very attractive to an adult, but a juvenile toad in the same situation is not. The fluttering of a moth is attractive and so is a running or crawling beetle. The hopping or crawling movement of a juvenile toad usually goes unnoticed as far as one can see. Occasionally such movements of a small juvenile causes the adult to orient toward it briefly as it does to a "legitimate" food object, but that is as far as it goes. The adult toad apparently "recognizes" the juvenile and hence does not attack.

Most toads do not strike blindly at potential food objects, even those that they eventually ingest. A toad seeing a crawling beetle usually orients toward it with eyes fixed upon it. If the beetle stops moving, the toad remains poised or crawls toward it and then remains stationary. If the beetle continues to move, or having stopped, moves again, the toad usually strikes immediately. If it remains quiet the toad usually moves away. Occasionally the toad may, after a few seconds, strike at the insect even if the observer fails to detect any movement. Exceptionally, some individuals obviously do not wait for a second movement. I once saw a *Scaphiopus couchi* leap at least six inches into the air to catch a flying moth that was just arriving and could not have been seen prior to this by the toad. For another example, I am indebted to the late Dr. J. Willis Stovall who told me of seeing a toad (species unknown) sitting beneath a mulberry tree and ingesting the berries as they fell from the tree and rolled and bounced along the ground.

These observations show for the species considered: (1) that movement of suitably sized objects attracts a hungry toad, but (2) that the kind of the movement is also an important factor in the releasing mechanism of feeding. It should also perhaps be noted that toads apparently differ from frogs (*Rana*) in these respects. It is well known that larger frogs eat smaller ones, even of their own kind and that it is easy to catch bullfrogs or grassfrogs by dangling a hook before them baited with no more than a piece of cloth. In my experience the cloth does not need to be *red.*

Selectivity: Selection as to size of food object is a common phenomenon in toads. Tiny juveniles cannot ingest anything except tiny objects. As they grow, they gradually increase the size of the food selected until, as adults, they commonly pay no attention to small insects if larger ones are readily available. At intermediate sizes they sometimes appear "puzzled" as to whether to attempt ingestion. For instance: a half-grown juvenile *Bufo c. speciosus* oriented toward a large June beetle which had just flown into a box and was crawling in front of the toad. Two other juvenile toads (one *B. cognatus,* the other *B. w. woodhousei*) of about the same size also oriented toward the beetle. Both of the latter soon backed away as toads characteristically do when rejecting a food object because of size. The little *B. c. speciosus* attacked and finally got its mouth closed completely over the beetle, but could not keep it closed. Soon the beetle's head appeared between the toad's lips and in spite of gulping on the part of the toad, crawled out and went on its way. The toad did not attack again, but backed away as the others had done with the characteristic avoiding reaction mentioned above. On numerous other occasions I have seen mid-sized juveniles behave in this manner, sometimes avoiding insects one would think they could swallow, and others attacking insects which were too large. I have seen young *S. bombifrons* avoid moths with small bodies and rather large wings which I was almost certain they could have swallowed easily. They were apparently fooled by the over-all size of the insect. I have also seen a very tiny juvenile of this species swallow a long, slim beetle larva which it met head on (and thus apparently did not interpret as large) that was actually longer than the toad itself, but not big in diameter. Occasionally, a juvenile males a real mistake: a juvenile *B. w. woodhousei* was killed

by ingesting too large a beetle (Bragg, 1948, Proc. Okla. Acad. Sci., 28: 35-36).

This gradual shifting to larger-sized food objects with growth was well shown by the following observations: As tadpoles of *S. bombifrons* metamorphosed, I had put them into a large container of soil above which a light had been placed to attract insects. Many kinds of insects visited the light, including a small dipteran and a small hymenopteran both of which moved their wings almost continuously as they crawled. Their movements attracted the smaller toads which ingested them greedily. Not one of these insects was attacked by several half-grown toads during continuous observation for an hour. The larger animals fed upon small June beetles, a few spiders and many small to medium-sized moths. I have noticed this same phenomenon many times in juveniles of other spadefoot species (*S. couchi* and *S. holbrooki hurteri*) and in *B. cognatus, B. t. charlesmithi* and *B. w. woodhousei.*

I have never known a toad of the species considered here to ingest a vertebrate in nature. However, we have recorded a case of a small adult *B. w. woodhousei* placed in a vivarium with an adult lizard (*Sceloporus undulatus*) which captured the latter during the night (Smith and Bragg, *op. cit.*). The next afternoon it voided the remains of the lizard so little digested that it was specifically identifiable. This observation suggests a correlation between a toad's usual avoidance of other vertebrates as food and a digestive mechanism not able to handle them. This might apply generally or only to certain species, but it is a matter upon which more data are needed. DEPT. ZOOLOGY and OKLA. BIOL. SURVEY, UNIV. OKLAHOMA, NORMAN.

PARASITISM OF SPADEFOOT TADPOLES BY *SAPROLEGNIA.*—On May 19, 1957, on a trip sponsored by the University of Oklahoma Biological Survey, we discovered along Highway 283 approximately 3 miles north of Sayre, Beckham County, a series of ditches of clear water containing tadpoles of *Scaphiopus bombifrons* of at least two age groups. In one ditch approximately 25 feet long, 10 feet wide and 8 inches deep (maximum), tadpoles were fewer than would be expected from even one clutch of eggs. Scattered about on the bank were dead tadpoles which had died in the water and were later stranded as the pool shrank. In the deepest water was a large mass of dead tadpoles and other dead tadpoles were scattered about. Some of the latter, as seen from the bank, had a fuzz of white threads extending from them. We suspected the water mold, *Saprolegnia.* a well-known parasite of fishes and other aquatic vertebrates. Dr. Howard Larsh, mycologist of the University of Oklahoma, confirmed our suspicions. These tadpoles had died of parasitism by this fungus.

In adjacent ditches on the same side (east) of the highway, a few dead tadpoles also occurred, but there was no evidence of parasitism in ditches on the other side of the road.

Saprolegnia has long been known on tadpoles but this is the first instance of which we are aware of parasitism in temporary water and the first known specifically on spadefoots. Judging from experience of more than 20 years which one of us (ANB) has had about temporary pools in Oklahoma, such a condition in this region must be rare.—*Arthur N. Bragg and William N. Bragg, Okla. Biol. Surv., Univ. Oklahoma, Norman.*

LAMPROPELTIS GETULUS CONJUNCTA (COPE) ON CERRALVO ISLAND, GULF OF CALIFORNIA, MEXICO.—During the summer of 1955 the Joseph W. Sefton Foundation of San Diego, California, sponsored a collecting expedition to the peninsula of Baja California for the Stanford Natural History Museum. On August 23 the senior author and Dr. Kenton L. Chambers made a brief visit to Cerralvo Island, the southernmost island in the Gulf of California. An adult male *Lampropeltis,* now No. 19634, was collected. It was observed about 11:30 p.m. crawling rapidly over the sand at the southern end of the island.

The following measurements in millimeters were taken after preservation: total length, 1143; tail, 117; standard length, 1026; head length, 22; head width, 18; dorsals 26-23-19; ventrals 231; caudals 60; supralabials 8; infralabials 10; 1 preocular; 2 postoculars; temporal formula, 2+4+4; loreal fused with postnasal.

This specimen possesses most of the characteristics of *Lampropeltis getulus conjuncta* (Cope) 1861, as redefined by Blanchard (1921, Bull. U.S. Nat. Mus., 114) and Schmidt (1922, Bull. Amer. Mus. Nat. Hist., 44, art. 11). It represents the second kingsnake and the first of this subspecies reported from any of the islands in the Gulf of California. In 1954, according to Cliff (Trans. San Diego Soc. Nat. Hist., 12: 75), *Lampropeltis catalinensis* Van Denburgh and Slevin (1921), a form considered endemic to Santa Catalina Island, was the only king snake known from any of the Gulf islands. Klauber (1936, Herpetologica, 1: 18-27) stated that *catalinensis* might eventually prove to be a pattern phase of *conjuncta.*

Klauber (*loc. cit.*) suggested that *conjuncta* should be considered a synonym of *californiae* Blainville. The authors feel that until specimens from intermediate areas linking the populations of *californiae* in central Baja California with those of *conjuncta* from the Cape Region demonstrate the connection of these two forms, the name *conjuncta* should be retained.—*John P. Figg-Hoblyn and Benjamin H. Banta, Natural History Museum, Stanford University, California.*

A SECOND REGAL RINGNECK SNAKE FROM NEVADA.—Only a single specimen of the regal ringneck snake, *Diadophis regalis regalis* Baird and Girard, has been reported from Nevada (Tanner, 1952, Great Basin Nat., 12: 63-64). It was secured 1 mi. E Caliente, Lincoln Co. The second, known to us, was collected near the same locality by the junior author July 9, 1956, at 4:10 p.m., swimming across a shallow stream in a narrow deep canyon above the confluence of Headwaters Wash on Beaver Dam Wash, 5290 ft., approx. 0.75 mi. W Utah boundary, in Lincoln Co.

The specimen, 630 mm. total length, was kept in a gallon jar for 6 weeks, during which time it was offered food in the form of one grasshopper, rejected; four recently metamorphosed *Bufo punctatus,* only one accepted; three *Uta stansburiana,* two accepted (50 mm. and 90 mm.); one 100 mm. *Sceloporus occidentalis,* accepted, but regurgitated the following day, and two 255 mm. *Thamnophis elegans vagrans,* both accepted.—*Benjamin H. Banta and Theodore C. Frantz. Natural History Museum, Stanford Univ., Calif., and Nevada Fish and Game Commission, Reno.*

Some Southern Races of the Common Water Snake, *Natrix sipedon**

By J. William Cliburn

This report presents information obtained during an investigation of *Natrix sipedon*, principally from the Gulf Coastal Plain. Topotypic *N. s. fasciata* from Charleston Co., S. C., *N. s. sipedon* from N. Y. and *N. s. pictiventris* from Fla. were examined for comparison with Gulf Coastal populations. The following symbols are used: MSC, Mississippi Southern College; UA, University of Alabama; LSU, Louisiana State University; CM, Charleston Museum; JWC, private collection of author, now part of the Mississippi Southern College collection.

Natrix sipedon pleuralis Cope

Material examined (24 specimens). *Miss.*: Ramsey Springs, SE Stone Co. (1); Bouie R. nr. Hattiesburg (1), artificial lake S Hattiesburg (3), Black Ck. and tributaries in S. Forrest Co. (7); Richton (1), Gaines Ck. nr. Beaumont (1). Thompson Ck. at Leaf R. (1), Perry Co; N Waynesboro (2), Wayne Co. *Ala.*: Russell Co. (1); Greene Co. (1); nr. Texas, Marion Co. (2); Tuscaloosa Co. (2). *N. C.*: Tusquitee, Clay Co. (1).

The record from SE Stone Co., Miss., represents a southward extension of range in the state, and is in keeping with Gordon (1952, Copeia, 2:116-117).

Variation. See Table II. Racially pure *pleuralis* may present two distinct dorsal patterns (Schmidt and Davis, 1941, Field Book of Snakes). Usually, there is a series of dorsal blotches alternating with a series of lateral bars. Less often there is a series of dorso-lateral bands, similar to the pattern of *fasciata* occurring in the Gulf Coastal area of Miss. Specimens of *pleuralis* displaying both types of pattern were taken over the entire area of its range included in this investigation. I found no geographical correlation with the dorsal pattern, nor with the number of body bands and/or blotches.

The ventral surface of typical *pleuralis* presents a series of semicircular to triangular spots, often arranged roughly in two parallel lines. Ventral pattern is a more stable characteristic for *pleuralis* than the dorsal pattern and is therefore considered to be of greater taxonomic significance. Ventral maculation of *fasciata* consists of quadrate markings. Four specimens of *pleuralis* whose ventral markings approach *fasciata* were seen. They were all from S Forrest Co., Miss. (JWC 18-32, 18-38, 18-42, 18-65). Three of these four specimens also have dorsal pattern typical of *fasciata*. Dorsal variations in *pleuralis* become significant when they are simultaneously linked with variation in ventral pattern. The simultaneous occurrence of a dorsal pattern consisting of bands and a tendency of ventral pattern to approach the quadrates of *fasciata* indicate intergradation between *pleuralis* and *fasciata* in S Forrest and Stone Co.

A blend of *pleuralis* with *confluens* is indicated by five specimens from East Feliciana, West Feliciana, and East Baton Rouge Par., La. (LSU 6110, 5816, 4822, 2883, 2863).

*Published with the aid of a grant from the Board of Trustees of State Institutions of Higher Learning, State of Mississippi.

Table I. Variations in *Natrix sipedon fasciata.*

	1 *fasciata* (S. C.)			*fasciata* (Ala.)		*fasciata* (Miss.)	
		N[2]					
Caud	68	28	63-85 (76.2)	8	67-85 (73.5)	9	64-78 (72.3)
Vent	132	35	126-137 (131)	11	124-133 (128.7)	15	126-140 (131.7)
Caud/vent	.515	28	.492-.651 (.563)	8	.527-.654 (.570)	9	.481-.597 (.553)
S R	23	7	23	11	23	13	23
		1	25			2	25
Sup-lab	7-7			11	8-8	13	8-8
						1	8-9
						1	9-8
Inf-lab				10	10-10	11	10-10
				1	10-11	2	10-11
						2	12-11
Post-oc				9	3-3	14	3-3
				1	2-2	1	2-2
				1	2-3		
Pre-oc				11	1-1	15	1-1
Ant temp				11	1-1	15	1-1
Post temp				4	3-3	10	3-3
				3	2-3	2	2-3
				2	3-2	2	2-2
				1	2-2	1	3-4
Tail/total	.135			8	.257-.290 (.269)	5	.243-.293 (.271)
Body bands	34.5	38	23-33 (28.5)	10	19-29 (24)	16	20-26 (22.1)

[1]*engelsi:* data from Barbour (1943), based on one specimen.

[2]N: number of specimens. Averages in parentheses.

Natrix sipedon fasciata Linnaeus

Material examined (66 specimens). *S. C.:* 38 specimens from various locations in Charleston Co. *Miss.:* 4 mi N Fontainebleau on Vancleave Rd. (2), Magnolia State Park, Ocean Springs (1), Jackson Co.; Perkinston, Stone Co. (1); 4 mi N Wade at Little Cedar Ck. (3), 6 mi SE

Saucier on Miss. HW 55 at Clear Ck. (1), Deer I., Miss. Sound (2), Harrison Co.; Napoleon (6), unknown locality (1), Hancock Co. *Ala.:* Point Clear (2), Daphne (2), Montrose (1), Ft. Morgan (1), nr. Spanish Ft. (1), Baldwin Co.; Alabama Port (1), Chickasaw (1), Wragg Swamp (1), Mobile (1), Mobile Co.

Variation. See Table I. The S. C. snakes are almost invariably very dark above, with maculations usually absent, or at best faintly visible laterally. When present, vestigial interspaces are ½ scale wide. One has light brown to tan dorsal ground color, with medium brown to dark brown bands, centers of bands usually slightly lighter than edges, and interspaces at mid-dorsum 1-2 scales wide. In three subadults, maculations are more discernible. One of these is very dark; the other two are lighter and their lateral interspaces lack dark centers.

Ventral coloration ranges from almost patternless to very prominently marked. In one specimen there is a red quadrate spot at the extreme end of every third or fourth ventral; on the posterior half of the body there is a mid-ventral row of faint, mottled, indefinitely shaped spots. Principal maculations in other specimens are usually sparse, involving only one ventral scale. In one, primary marks often involve more than one scale, approaching the condition prevailing in Miss. specimens. Two juveniles (CM 53.63.2, 53.65) have ventral marks which suggest *N. s. sipedon.* Another (CM 37.180) suggests *pictiventris.*

Dorsal coloration and ventral pattern are extremely variable in these specimens. Assuming these snakes to represent *fasciata,* we conclude that these characters are not diagnostic, at least in this part of the range of *sipedon.*

Snakes from the Gulf Coast of Miss. reveal consistent variation in ventral pattern when compared to more easterly *fasciata.* In Miss. *fasciata,* individual ventral maculations generally involve at least two scutes, indicating probable influence of *confluens.* Lateral bars extend onto ventrals to form conspicuous marks, generally roughly quadrate, which sometimes oppose and sometimes alternate with the marks from the other side. These marks extend to approximately mid-venter, occasionally contacting a mark from other side. Other prominent markings occur among primary spots. They are variously shaped and placed, but usually are in opposition to a primary spot. Secondary spots involve 1 to 3 scales. Ventral ground color light yellow with blotches tending to form two longitudinal rows; chin and throat immaculate pale yellow; tail banded dorsally and much marked ventrally.

Dorsal ground color light brown to grayish, usually light brown; dorsal bands typically dark reddish brown to black, wide and irregularly shaped, often fused, especially on posterior part of body; dorsal interspaces generally 1-1½ scales wide, becoming wider laterally; lateral interspaces generally much wider than lateral portions of bands; lateral interspaces usually with dark centers, suggestive of lateral bars, alternating with bands, to which they are often fused; top of head dark brown to black; upper labials light brown with dark vertical line at posterior edge of each scale; dark line posteriorly from eye to last of upper labials.

In *fasciata* from Coastal Ala., dorsal ground color ranges from light brown to dark brown. Dorsal bands usually quite dark and prominent,

with tendency toward fusion of bands, especially on anterior part of body; in one semi-melanic specimen, dorsal markings practically obliterated.

Ventrally, there are considerable differences in general shape and arrangement of marks, which are frequently not quadrates. The most conspicuous marks are continuations of dorso-lateral marks and usually involve only one ventral plate. Irregular marks (sometimes narrow stripes, occasionally extending across entire venter, sometimes almost equilateral quadrates, and sometimes of very irregular outline) interspersed among some of more prominent marks. Generally the most conspicuous extend approximately to mid-venter, sometimes contacting alternating mark from other side. In some specimens, ventral maculations are much reduced in size and number, dorsal ground color is light brown, and dorsal marks tend to be light reddish brown.

A specimen (UA 51-19) from Houston Co., Ala., has ventral marks which approach those of *pictiventris*. On the neck, in particular, marks have narrowed into thin lines which extend across mid-venter.

The distinctions between *confluens* and *fasciata* have been arbitrarily drawn (Blanchard, 1923, Occ. Pap. Mus. Zool. Univ. Mich., 140:1-7), since variations within *sipedon* in the Coastal Plain represent an east-west gradient, with no distinct break existing between the coastal forms. The gradients are shown in the accompanying graphs, which indicate the ranges, averages, and standard deviations of significant characters from various parts of the geographic range. There is a general increase in the number of ventrals toward the west (Fig. III); there is also a westward trend toward a smaller number of dorsal body bands, resulting from a fusion of the more numerous bands of the eastern races (Fig. 1); ventral markings become individually larger and more prominent toward the west. With regard to the average number of bands, Miss. *fasciata* stands closer to *confluens* than to Charleston *fasciata*. This is true also with average caudal count (Fig. II), and with the average number of ventrals. Regarding caudals, the Charleston population shows a range of variation greater than that of all *fasciata* from the entire Coastal Plain, although the average for the Charleston group is higher. In number of dorsal bands and in number of caudals, Charleston *fasciata* indicates the effect of *pictiventris*. Ala. *fasciata* shows the effect of *pictiventris* most strongly in average ventral count.

There is much greater constancy of coloration, of ventral pattern, and of scalation in both the Ala. and Miss. populations than in the Charleston group.

The status of *fasciata* is doubtful. The type locality lies within a region of intergradation; topotypic material is extremely variable, showing influences of *sipedon, pictiventris,* and the population of the Coastal Plain to the south and west. If *engelsi* is valid, as discussed below, then the form presently called "*fasciata*" consists of a complex of several subspecies. Until further study permits a reliable conclusion, I suggest the name *fasciata* be retained as now used.

Natrix sipedon engelsi Barbour

Material examined. None. All data from Barbour (1943, Proc. N. Eng. Zool. Club, 22:1-2).

Fig. I: Numbers of dorsal body bands.

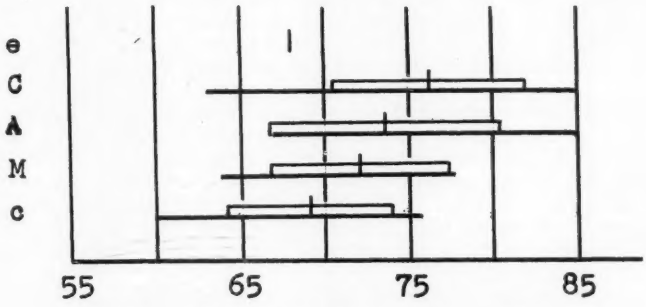

Fig. II: Numbers of caudals.

Fig. III: Numbers of ventrals.

These symbols are used: e, *engelsi;* C, Charleston *fasciata;* A, Ala. *fasciata;* M, Miss. *fasciata;* c, *confluens.* Horizontal line represents total range of variation; vertical line represents mean; horizontal bar represents standard deviation from mean.

Variation. See Table I. An objective evaluation of *engelsi* is difficult. This form was described in 1943 from a single specimen. The only claims to distinction possessed by *engelsi* are an aberrant ventral pattern and a dorsal band count which is slightly higher than that of *fasciata,* but within the limits of both *pictiventris* and *sipedon.* In the latest edition of the checklist (Schmidt, 1953, A Check List of North American Amphibians and Reptiles), its range was still limited to the type locality; apparently no other examples were known, although 10 years had passed since the description.

As discussed above, *fasciata* is extremely variable in S. C., and this area is in the blend zone of northern and southern races. Ventral pattern of *N. sipedon* in this area is highly inconstant. The description and color illustration of *engelsi* indicate that the type specimen is a further example of the variable ventral pattern.

All characters of *engelsi* fall within the ranges of the forms which intergrade in the area. It is difficult to state that 70% of the specimens of *engelsi* are distinctive from either *fasciata* or *sipedon,* since such specimens do not exist; the one specimen known is not distinctive. To base a subspecies description on an unusual ventral pattern in a single specimen is folly; by such a standard, hundreds of "subspecies" of *sipedon* may be described in the Southern Coastal Plain. To recognize *engelsi* as distinct from *fasciata* on the basis of a higher dorsal band count would necessitate recognizing the Miss. specimens also as distinct, since 95% of Miss. specimens have a band count lower than 70% of the S. C. snakes. Likewise, approximately 70% of the Ala. snakes are distinctive in this respect from 70% of the S. C. specimens. Thus, if dorsal band count is to be the criterion, what is now called *"fasciata"* consists of at least three subspecies.

The name *engelsi* obviously applies to an individual snake, and not to a population, as the lack of specimens attests. The recognition of *engelsi* is not justified. It is an intergrade specimen, standing closer to *fasciata* than to *sipedon,* and is a synonym of *fasciata,* as presently understood.

Natrix sipedon confluens Blanchard

Material examined (45 specimens). *La.:* Paradis (10), Sarpy Refuge (1), St. Charles Par.; Schriever, Terrebonne Par. (10); Erwinville, West Baton Rouge Par. (1). *Miss.:* Beulah, Bolivar Co. (1); Schlater, Leflore Co. (1); W McComb, Amite Co. (1); Napoleon, Hancock Co. (5); Municipal Airport, 5 mi SE Hattiesburg, Forrest Co. (1). Specimens observed in the Miss. Game and Fish Commission Museum are recorded from the following Miss. counties: Carroll, Coahoma, Hancock, Hinds, Holmes, Warren, Washington, Wayne, and Lauderdale (Cook, 1943, The Snakes of Miss., State Game & Fish Comm. Surv. Bull.). The latter two counties are in eastern Miss., bordering Ala.; these, and the Forrest Co. specimen, indicate that the range of this form extends much farther eastward than previously generally realized. (Incidentally, Blanchard (*op. cit.*) cites a specimen from Jefferson Co., in SW Miss., but on his map the specimen is recorded from Jefferson Davis Co., which is much farther to the east.)

Variation. (Specimens in Game and Fish Commission Museum not included.) See Table II. Two distinct trends in ventral pattern appear

Table II. Variations in coastal plain *Natrix sipedon*.

	confluens		*clarki*		*pleuralis*	
	N		N		N	
Caud	31	60-76(69.2)	14	72-83(77.4)	24	61-88(69.8)
Vent	44	127-140 (133.1)	14	127-137 (132.6)	24	130-151 (135.6)
Caud/ vent	31	.455-.576 (.518)	14	.541-.629 (.589)	24	.424-.631 (.516)
S R	38	23	13	21	22	23
	6	25	1	20	2	25
Sup-	40	8-8	13	8-8	22	8-8
lab	1	7-7	1	9-8	1	9-8
	1	8-7				
	1	9-8				
Inf-	32	10-10	8	10-10	18	10-10
lab	4	11-11	2	11-10	2	9-9
	3	10-11	2	10-9	1	9-10
	2	9-10	1	10-11	1	10-11
	2	11-10	1	12-12	1	11-10
	1	9-9				
	1	10-9				
Post-	34	3-3	9	2-2	20	3-3
oc	4	2-3	3	3-3	2	3-2
	3	3-2	1	2-3	1	2-2
	2	2-2	1	3-2		
	1	4-4				
Pre-	45	1-1	14	1-1	19	1-1
oc					4	2-2
Ant	43	1-1	14	1-1	24	1-1
temp	1	2-1				
Post	30	3-3	12	3-3	9	3-3
temp	5	3-2	1	2-3	6	2-2
	3	4-3	1	3-2	3	2-3
	3	2-2			3	1-1
	2	2-3			5	3-2
	1	3-4				
Tail/ total	30	.212-.319 (.246)	14	.226-.263 (.250)	24	.190-.281 (.249)
Body bands	40	12-20(15.1)			24	6-28(16.3)
Body blotches					24	0-23(10.5)
Bands + blotches					24	20-31(26.3)

in a series of *confluens* from SW New Orleans. In some, ventral spots are arranged chiefly in two rows. In others, this arrangement is replaced by an irregular single row of prominent spots, often alternating with other markings which are continuations of the dorsolateral bands. The latter arrangement also occurs in examples from Amite and Leflore Co., Miss. All specimens collected in Hancock Co., Miss., have ventral marks

in two rows, approaching the condition of Miss. *fasciata.* There is a reduction in average number of body bands in *confluens* proceeding westward and northward from Pearl River off lower Miss., where range of *confluens* joins that of *fasciata.* Likewise, there is an increase in average number of ventrals. *N. s. confluens* shows the influence of *fasciata* in ventral pattern, in number of dorsal bands, and in number of ventrals, especially in Pearl River Valley. A blend of the two subspecies apparently occurs in lower Pearl River Valley.

One snake (MSC 55-357), from 6 mi W Hattiesburg, Lamar Co., Miss., is considered to be intermediate between *confluens* and *fasciata.* The genetic influence of *fasciata* thus extends approximately 35 miles farther north than is shown by the collection of "typical" *fasciata.* The ranges of the three forms (*pleuralis, confluens,* and *fasciata*) thus overlap in the Stone-Forrest-Lamar Co. area, as shown by the occurrence of *confluens* in Forrest Co., of *pleuralis* in Forrest and Stone Co., of *confluens* x *fasciata* in Lamar Co., and of *pleuralis* x *fasciata* in Stone and Forrest Co.

Natrix sipedon clarki Baird and Girard

Material examined (19 specimens). *Ala.:* Dauphin I. (5), Coden (6), Cedar Point (1), Mobile Co. *Miss.:* Gulf Coast Research Laboratory, Ocean Springs (2), Jackson Co. *La.:* Grand Isle (4), Jefferson Par.: Phoenix (1), Plaquemines Par. Allen (1932, Amer. Mus. Nov. 542:1-20) found *clarki* on Horn I. and in Harrison Co., Miss. Smith and List (1955, Amer. Midl. Nat., 53:1, 115-125) collected *clarki* on Deer I., Harrison Co.

Variation. Data from 14 Ala. and Miss. specimens. See Table II. Four *clarki* from Grand Isle, Jefferson Par., La., possess lateral dark lines which break up immediately anterior to the vent to form blotches, suggesting *confluens.* The tail of one is prominently blotched on the sides. No variation of significance was observed in ventral patterns.

Specimens of *clarki* from Dauphin I., Mobile Co., Ala., show a tendency of lateral stripes to break posteriorly to form blotches.. In one, lateral light stripes of ground color are definitely and prominently broken by black splotches which join the dark dorsal stripe to the lateral dark stripe. Posteriorly, dark areas extend faintly across the dorsal light stripe. Dark areas of the belly also join across the midventral light stripe on each scale on the posterior two-thirds of body, to break it up into a series of light spots. Specimens from Coden, Mobile Co., also have stripes which are broken, especially posteriorly. In one, the left dorsal stripe is broken on the anterior part of the body in two places. In another, dorsal and lateral stripes nearly meet at regular intervals on anterior part of body. They completely join at intervals posteriorly and on tail to form indications of bands. These variations, together with the tendency toward melanism in Ala. *fasciata,* may indicate a blend of *clarki* with the latter in coastal areas of Ala.

Specimens of *clarki* collected at Gulf Coast Research Laboratory, Jackson Co., are typical, as are specimens of Miss. *fasciata* from this same region. No intergradation is indicated. Typical examples of Miss. *fasciata* from Deer I., Harrison Co., have been examined. *N. s. clarki* also occurs on Deer I. The collection of typical examples of *fasciata* and typical *clarki* in the same limited range in Jackson Co., and on Deer I., suggests

either that *clarki* may not properly be considered a member of the *sipedon* group, representing instead a separate species recently evolved from the common parent stock, or that the two forms are effectively isolated by distinctive habitats within the common range. (It has been pointed out to me by B. D. Valentine that Ala. *fasciata* is at least occasionally an inhabitant of brackish water, which is an objection to the latter possibility.)

A snake (LSU 2868) from Phoenix, Plaquemines Par., La., appears to be intermediate between *clarki* and *confluens*. Dorsal markings are typical of *confluens*, while ventral maculation approaches very closely that of *clarki*. The following conclusions appear to be warranted: The east-west trend of Gulf Coastal members of the *sipedon* group toward individually larger ventral marks reaches its climax in the two parallel ventral stripes of *clarki*, which are formed by a fusion of the individual paired markings of *confluens*. The dorsal stripes of *clarki* resulted from the final fusion of the bands of *confluens*, which were derived from a fusion of the more numerous bands of the eastern subspecies. I believe that *clarki* evolved from banded ancestry in the lower Miss. Valley and then spread eastward by means of brackish water to occupy the present range. Due in part to its brackish water habitat, and in part to its more distant relationship to the Miss. and Ala. populations of *fasciata*, *clarki* can occupy the same range as these forms, and yet maintain its identity. Possibly the broken dorsal stripes in *clarki* in La. and Ala. do not represent intergradation, but represent instead a partial reversion to the ancestral dorsal pattern. Whether the broken stripes of *clarki* be interpreted as evidence of intergradation or of reversion, this characteristic—plus evidence presented above—indicates the banded ancestry of *clarki*.

SUMMARY

The range of *N. s. pleuralis* has been extended southward in Miss. to within 25 miles of the Gulf of Mexico. *N. s. pleuralis* intergrades with *confluens* in the region of Baton Rouge, La., and with *fasciata* in Stone and Forrest Cos., Miss.

The range of *fasciata* in Miss. extends northward 30 miles from the coast to south Stone Co. It is narrowest in Hancock Co., where *fasciata* has not been found more than 10 miles from the coast. Miss. *fasciata* intergrades with *confluens* to the west, and with *pleuralis* to the north. Three populations of *fasciata* have been studied and gradients with respect to several characters have been demonstrated. The name *engelsi*, is declared invalid, properly referring to a highly variable intergrade population occurring in the Atlantic Coastal Plain.

N. s. confluens occurs in Miss. in the Pearl, Miss., Yazoo, and Pascagoula R. drainages. It intergrades with *fasciata* to the east, and with *clarki* in Plaquemines Par., La. Two types of ventral patterns are known.

N. s. clarki is limited in range largely to a narrow belt along the Gulf of Mexico. Its range overlaps that of *fasciata* in brackish water habitats of Miss. and Ala.

There exists in the *Natrix sipedon* complex in the southern Coastal Plain an east-west gradient in number of ventrals, dorsal bands, and in ventral maculation, with no distinct break between the forms. The westward trend toward a reduction in number and subsequent fusion of

both dorsal bands and ventral marks reaches its culmination in *clarki*, which has been derived from *confluens*. Specimens showing intergradation of *clarki* and *confluens* are known. *N. s. clarki* is more closely related to *confluens* than to any other member of the *sipedon* group. Although *clarki* occupies a common range with *fasciata*, the absence of intergrade specimens indicates a more distant relationship. The tendency toward a breaking of stripes to form bands and blotches in some specimens of *clarki* indicates the banded ancestry of *clarki* and the unstable genetic pattern which permits a partial reversion to the ancestral form.

ACKNOWLEDGMENTS

I acknowledge the courtesy of the following people who generously permitted the examination of specimens: Mr. C. B. Segars and Mr. B. D. Valentine, Museum of Division of Biological Sciences, Mississippi Southern College, Hattiesburg; Dr. Ralph L. Chermock, Museum of Department of Zoology, University of Alabama, Tuscaloosa; Miss Fannye A. Cook, Mississippi State Game and Fish Commission Museum, Jackson; Dr. George H. Lowery, Museum of Natural History, Louisiana State University, Baton Rouge; Dr. Albert Schwartz, Charleston Museum, Charleston, S. C. Mr. C. B. Segars and Mr. B. D. Valentine read parts of the manuscript, and their criticisms and suggestions have been very much appreciated. I am grateful also for the comments of Mr. Chapman Grant and Dr. Hobart M. Smith.

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LIZARDS EATEN BY SCORPIONS.—Snakes may be preyed upon by scorpions as has been pointed out by Anderson (1956, Herpetologica, 12: 327), who records the ingestion of a blind snake (*Leptotyphlops humilis*) by a large *Centruroides*. The following observations pertain to lizards.

On April 4, 1953, a live 160 mm. adult *Urosaurus ornatus symmetricus* Baird, was placed in a gallon glass jar containing an adult scorpion, *Vejovis* sp. Both animals had been collected on the west side of Black Canyon on the west side of the Colorado River, Clark County, Nevada. Neither showed immediate concern for the other, so little attention was paid to them. The next morning disclosed that the lizard had been killed and was being consumed by the peculiar method of external digestion used by scorpions. Light brownish liquid was streaming from the lizard carcass into the scorpion's mouth. Within 24 hours all parts of the lizard except the end of the tail had been completely eaten.

During the spring of 1955 the author buried cans and jars as traps for reptiles in southern and western Nevada. Frequently such traps contained lizards and scorpions. On several occasions the partially digested remains of a lizard, in all cases *Uta stansburiana* were found in the same can with a live scorpion.—*Benjamin H. Banta, Nat. Hist. Mus., Stanford Univ., Calif.*

An Ecological Study of the Plain-Bellied Water Snake

By RICHARD A. DIENER

Notes on various aspects of the ecology of the Plain-bellied Water Snake, *Natrix erythrogaster* Forster, have appeared in the literature from time to time, but no careful analysis in any part of the geographic range has been recorded. The present study concerns two subspecies of *N. erythogaster: N. e. flavigaster* Conant and *N. e. transversa* Hallowell. The habits of sympatric species of *Natrix,* particularly *sipedon,* are contrasted where possible with those of *erythrogaster,* with attention directed primarily to the devices preventing direct competition.

Methods and Materials. Field studies were confined to the warmer months of 1955 and the spring of 1956, and were carried out in parts of Arkansas, Kansas, Missouri, Oklahoma, and Texas. The exact localities are as follows (the letters "e," "r," or "s" after each locality denote *erythrogaster, rhombifera,* or *sipedon*).

ARKANSAS: *Benton Co.*—Illinois River, about 5 mi SE Siloam Springs on Ark. 16 (e, s); White River at Monte Ne (s); Osage Creek branch 3 mi. S Cave Springs (s); Crystal Lake 1 mi. NE Decatur (s); and Lake Atalanta about 1 mi. NE Rogers (s). *Washington Co.*—Clear Creek, 5.2 mi. N Fayetteville on Ark. 112 W bridge, and S Savoy from bridge west to Illinois River (e, s); West Fork of White River 4 mi. S Fayetteville and W U.S. 71 (e, s); ponds W Illinois River, 7.2 mi. NW Fayetteville on Ark. 16 (e); White River about 6 mi. E Springdale on Ark. 68 (e, s); Illinois River 5 mi. NE Lincoln on rural road (e); Lake Wedington about 10 mi. NW Fayetteville on Ark. 16 (s); Richland Creek E Fayetteville on Ark. 45 (s).

KANSAS: *Meade Co.*—Brooder ponds at Meade County State Park (e, r); Big Spring Creek about 5 mi. W Kans. 23 (r). *Seward Co.*—Cimarron River 5.8 mi. SW Kismet and E U.S. 54 (r).

MISSOURI: *McDonald Co.*—Little Sugar Creek 0.5 mi. S Pineville on Mo. 88 (e, s); Indian Creek about 2 mi. E Lanagan on Mo. 88 (s); and Elk River 1 mi. S Elk Springs E U.S. 71 (s).

OKLAHOMA: *Sequoyah Co.*—Sallisaw Creek 3 mi. S Marble City (e, s).

TEXAS: *Gonzales Co.*—Brooder ponds adjacent to Palmetto State Park (e).

The habitat, vegetation types, and temperature of the air, water, and ground at points of capture were taken into consideration. Rates of water flow (computed in feet per minute), food taken, and the potential food available to the snakes were also recorded. Food was forced from the stomach and preserved in the laboratory. In Kansas the snakes were marked as described by Blanchard and Finster (1933).

Habitats. Numerous accounts of the habitats of *erythrogaster* are scattered in the literature, but most lack specific details. Conant (1934: 26) states that *erythrogaster* in Ohio inhabits small woodland ponds which frequently become dry in mid-summer, and that it is more common there than *sipedon,* whereas the latter is more common where there is permanent water to assure food and cover. Cagle (1942: 190) states

that *erythrogaster* abounds in sloughs and muddy drainage ditches, but is rarely found in clear rock-bottomed streams with *sipedon*. Conant (1955: 3) states that *erythrogaster* in New Mexico stays in groups around small quiet pools where there are reeds and shade.

In general, *sipedon* is considered to be partial to a more aquatic habitat than is *erythrogaster*. Conant (1942: 167) found *sipedon* under rocks along the open parts of clear rocky streams. He earlier records (1938: 85) that *sipedon* was abundant around permanent bodies of water and frequently found in intermittent streams but absent from streams heavily polluted with industrial waste.

It appears that both *erythrogaster* and *sipedon* occupy a similar habitat so far as temperatures are concerned. Only one to three snakes of either species were seen while the air was 55°F or lower for a day, and no snakes were seen if this low temperature persisted over two days. Shallow bodies of water without current or with a slow rate of flow were, however, found to be 3° to 8°F warmer than rapidly running water.

N. erythrogaster and *sipedon* were often found in the same streams. It was noted that *sipedon* might be found in the faster water but that *erythrogaster* tended to select isolated pools. Measurement of the flow at the point of capture showed that *erythrogaster* has a preference for slow moving water (range 0-50 ft./min., av. 12.9 in 42 observations), whereas *sipedon* is more generally distributed but shows a preference for more rapidly moving water (range 0-80 ft./min., av. 34.8 in 72 observations).

The species differed in their tendencies to wander from water. Measurement of the distance from the point of capture to the nearest water for each snake found on land revealed a less striking difference between *erythrogaster* and *sipedon* than in their preference for lentic vs. lotic waters, but both species differ markedly from *rhombifera* in this respect. Although a large proportion of individuals of all three species was found in water, both the means and the extremes indicate that *erythrogaster* tends to wander farthest from water (range 0-150 ft., 75 observations), with a mean of 13.7 feet as compared to 2.1 feet for *rhombifera* (range 0-10, 12 observations) and 9.3 feet for *sipedon* (range 0-35, 76 observations).

The findings of Tihen and Sprague and of Conant verify these results. Tihen and Sprague (1939: 504) found that *erythrogaster* could often be found farther from water than *sipedon* (not seen in Kansas). Conant (1934: 26) in Ohio found that 30 *erythrogaster* were farther from water than several hundred *sipedon*. One *erythrogaster* was a full 200 yards from the nearest pond.

The habitats of *erythrogaster* were of two basic types: either quiet portions of streams, or isolated ponds. Clear Creek, north of Fayetteville on State Highway 112 and west of the bridge, is a good example of a drainage which has the characteristic habitats of both *erythrogaster* (Plate I, above) and *sipedon*. The current varies from 0 in the pools to about 120 feet per minute in the rapid currents of the streams. Populations of *erythrogaster* are found along the slower portions of the streams, with currents up to 25 feet per minute, and *sipedon* may also occur in that zone. Portions of the streams that run faster than 25 feet per minute are almost always devoid of *erythrogaster*, but *sipedon* occurs there in numbers.

Pl. 1. *Above.* Clear Creek, about 2000 feet west of State Highway 112 bridge 5.2 mi. north of Fayetteville, Washington Co., Arkansas. Habitat typical of a population of *Natrix erythrogaster* with a small group of *sipedon*. Current about 15 feet per minute. *Below.* Isolated pond about 1025 feet west of Illinois River, 7.2 mi. west of Fayetteville, Washington Co., Arkansas, on State Highway 16. *N. erythrogaster* only has been found here.

The vegetation bordering the margins of Clear Creek varies from open grasslands, devoted to grazing, to cultivated fields and woods of secondary growth. In places where the current is slow the vegetation is primarily of tall grasses, often in mats, and saplings to full grown trees. The margins of swift water are bordered by short grasses, reeds and piles of driftwood. Another type of habitat, the small isolated pond, is characterized by a series of abandoned river meanders on the west side of the Illinois River northwest of Fayetteville (Pl. I, below); and a semi-isolated pond adjacent to the Illinois River about five miles northeast of Lincoln. These ponds have no current and the vegetation is typified by secondary-growth woods.

A part (June to August, 1955) of this study was carried out in and around Meade County State Park, Kansas. Due to droughts from 1952 through 1955 the habitats of *erythrogaster* were restricted to permanent ponds (the brooder ponds). Tihen and Sprague (1939: 504) have already stated that *erythrogaster* is partial to semi-aquatic regions in the Park, particularly around the brooder ponds shared with *sipedon* (not seen) and *rhombifera*. The brooder ponds are joined by one to three control gates which regulate depth, seldom over 3 ft. The vegetation is characterized by reeds or cattails in places where the current is about 50 feet per minute, chiefly about the ends of the drainage control gates. Where the current is about 15 feet per minute, the vegetation includes cottonwoods, willows and short grasses. Beyond this marginal vegetation, buffalo grass predominates with some poison ivy, yucca, and a few cottonwoods and willows. On the highest ground cacti (*Opuntia* spp.), sagebrush, coarse herbs and plum thickets occur, all typical of a semi-xeric region.

Natrix erythrogaster was found to prefer the marginal habitats bordering slow moving water (15 captures in slow water, 1 in fast). Two were found crawling through buffalo grass well away from any pond, perhaps changing feeding grounds due to desiccation of a pond. *N. rhombifera*, on the contrary, preferred fast water (10 captures in fast, 2 in slow).

Seasonal Activities. Natrix erythrogaster was first observed in the middle of March in both 1955 and 1956. The snakes could be seen in limited numbers basking on logs, driftwood, or on top of matted vegetation, when the temperatures ranged around 60°F during mid-afternoon, but they were not found at night. However, with longer days and more prolonged warm temperatures they appeared in greater numbers basking from around 8:00 A.M. to 5:00 P.M., and at night foraging for food. The snakes could nearly always be found in early evening foraging in isolated ponds, but in such habitats as Clear Creek they were active until 3:00 A.M.

In the late summer and autumn, the nights became cooler while the days remained warm. Then *erythrogaster* was either basking or foraging during the morning.

Before winter set in, the snakes were often found under rocks, logs, boards, and piles of driftwood where they may hibernate. The snakes that were found under small rocks, logs and boards were mostly juveniles and these might have perished had they remained there during the winter months since they were under insufficient cover. Larger individuals and

a few juveniles were found under brush piles which gave them more protection.

The associated species of *Natrix* did not deviate from this daily pattern to any great extent. *N. sipedon,* however, did seem to differ in foraging in early evening and in disappearing into protective cover after midnight. *N. rhombifera* in Kansas had the same habits as *erythrogaster* as far as could be determined, feeding and basking at the same times. This observation is based on only a few records.

Shedding of the skin occurred throughout the season for all species. Casts were frequently found along the margins of streams and ponds, and under piles of driftwood and logs. During their moulting the snakes tended to be inactive and often were found under matted vegetation or brush piles or coiled on the top of logs.

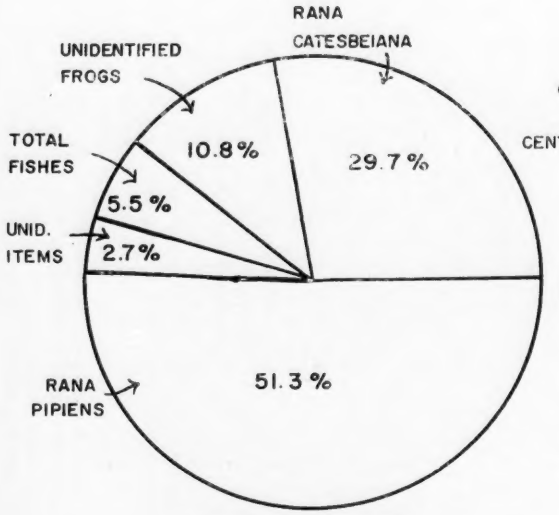
Feeding. The locality studied in Kansas is different from those in other states relative to available food as well as to the items taken. Therefore the Kansas locality is here treated separately.

IN LOCALITIES OTHER THAN KANSAS, the food of *erythrogaster* and *sipedon* has been mentioned in the literature as consisting primarily of fish and amphibians. Ditmars (1907: 251) stated that a specimen he collected of *Natrix "sipedon" erythrogaster* "disgorged eleven suckers, three sunfish and a crawfish." Blanchard (1925: 384) found that an Indiana specimen yielded seven large tadpoles and a larval salamander. Conant (1938: 73) found that an *erythrogaster* disgorged a leopard frog (*Rana pipiens*). Even though Ditmars' observations appear to indicate heterogeneous feeding, those of Conant and Blanchard seem to point to an amphibian diet. Schmidt and Davis (1941: 223-224) stated that *sipedon* feeds largely upon fish, and Ditmars (1946: 163-164) stated it has been captured by baiting hooks with perch. Cagle (1942: 191) found *sipedon* to have taken sunfish (*Lepomis humilis*), bullfrogs, and small leopard frogs.

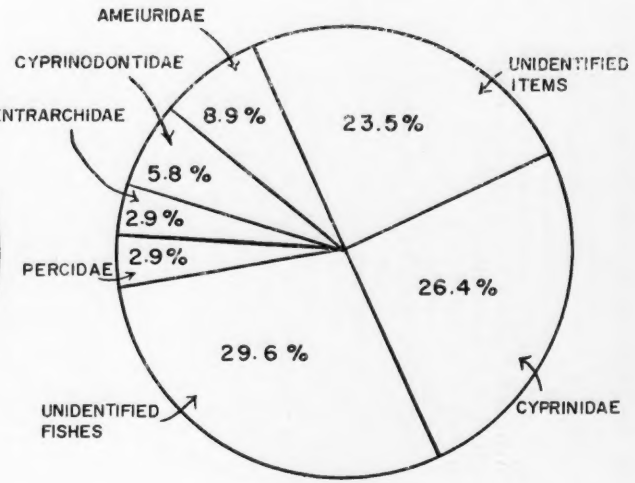
Evans (1942: 53-55) described three species of snakes (*Natrix erythrogaster* and *sipedon,* and *Thamnophis sauritus*) as feeding by swimming with their mouths open, and closing them upon contact with a fish. No snake studied in this report was observed to do this. Instead, they seemed to stalk their prey with mouths closed, remaining near the shore most of the time.

Natrix sipedon was seldom found foraging during the day, but *erythrogaster* appeared to be diurnal during early spring and late summer and autumn, becoming nocturnal only toward mid-summer. Roughly 8% of *sipedon* seen appeared to be foraging between 10:00 A.M. and 4:00 P.M., whereas about 23% of *erythrogaster* was actively foraging during this period. Stomach contents of *sipedon* captured during the day were usually well digested, whereas at night they were fresh. The same general pattern is found in *erythrogaster,* but the fresh food occurred slightly more frequently in specimens captured during the daytime.

The food of *sipedon* consists almost entirely of fishes, the bulk being minnows (Cyprinidae). This is in contrast to *erythrogaster* which is partial to frogs, with a small percentags of fish (Fig. 1). The literature on the food of *erythrogaster* appears to indicate that in other parts of its range it is not as restricted in its diet as this study shows.



N. ERYTHROGASTER
(34 Individuals)



N. SIPEDON
(37 Individuals)

The number of fishes found in each stomach examined was one, except for a single *sipedon* which contained two. The number of frogs in *erythrogaster* ranged from one to five for *Rana pipiens* (av. 2.4 in 19), one to four for *R. catesbeiana* (av. 2.0 in 11).

IN KANSAS the food habits of *transversa* were observed only at the brooder ponds in the State Park in Meade Co. The situation there is considered different from those studied elsewhere inasmuch as the habitat is different and *erythrogaster* is associated with *rhombifera* rather than with *sipedon*.

There appeared to be a wide choice of fish, amphibians and crayfish, but *Rana pipiens* was the most readily available food, and the only food identified in the stomach of 17 *erythrogaster*. No immature snake examined contained more than one frog; mature snakes had as many as five. Most of the frogs were of the early hatch, with larval tails bringing the average total length of the young frog to 42 mm.

The frogs appeared to be more numerous in cottonwood and willow, which gave them more freedom of movement than did reed or cattail habitats. This habitat was also preferred by the snakes. Crayfish and various species of small fishes were numerous, but many were dying and dead, probably due to the lack of oxygen caused by excessive temperature of the water in the ponds. Only a few fishes over six inches in length were seen.

N. sipedon, previously known to inhabit the region, was not seen, perhaps due to its intolerance to long periods of drought. Tihen and Sprague (1939: 504) stated that it and *erythrogaster* are very destructive of young fish in the brooder ponds. Smith (1950: 263) stated simply that the food of *rhombifera* is made up primarily of fishes although the few snakes observed took amphibians only.

Reproduction. Mating occurs in *erythrogaster* in early April and throughout May in the southern part of its range. On May 20, 1955, in Washington County, Arkansas, three large individuals were observed at Clear Creek, west of the State Highway 112 bridge. Two individuals were mating while the third lay stretched alongside, about five inches from the mated pair. The sex of the third individual was not determined.

The oviducts of five gravid females captured from late June through July in western Kansas contained from five to 21 ova (mean about 12). The definitive outline of the embryo was not seen in the ova prior to July 17. The lengths of the eggs ranged from 27 mm. in snakes captured during late June to 43 mm. in snakes captured during late July. The coil diameter of the late July embryos averaged 14 mm.

Predation. Several individuals in Kansas and Arkansas were observed to have portions of their tails missing. This may be due in part to

Fig. 1. Food consumed by two species of *Natrix* expressed in percentages of food items represented. Species of fish represented are *Micropterus salmoides* (Centrarchidae); *Schilbeodes insignis, S. miurus* (Ameiridae); *Fundulus* sp. (Cyprinodontidae): *Hyborhynchus notatus, Chrosomus erythrogaster, Nocomis biguttatus, Hybopsis biguttata, Campostoma anomalum* (Cyprinidae); and *Poecilichthys spectabilis* (Percidae).
were found in only 2.3% of the stomachs of *Chelydra* examined. It may

turtles. Carr (1952:67) states that vertebrate remains, other than fish, were found in only 2.3% of the stomachs of *Chelydra* examined. It may be assumed that the greatest danger to *erythrogaster* from natural predators comes during the first few years of life, and that natural predation is a small but important factor in population control.

Conclusions. *Natrix erythrogaster* differs from both *sipedon* and *rhombifera* in preferring localities with still or slow moving water and in occurring at considerable distances from water; as a primarily frog-eating snake it differs sharply from *sipedon* which is primarily piscivorous. The difference in food habits is correlated directly with the differences between *erythrogaster* and *sipedon* in preference of lentic vs. lotic water and the distance they may stray from water. Although sympatric over much of their ranges, the latter two species appear to have significantly different ecological requirements and are not importantly competitive.

N. erythrogaster is usually found basking and foraging during the daytime in the spring and autumn. In mid-summer, it either basks or hides during the day, but forages late at night. In the region investigated, *erythrogaster* shows a preference for frogs, even though some literature indicates that it may have more heterogeneous feeding habits in other parts of its range. Mating occurs during early April and throughout May.

No evidence of natural predation was found other than that a few individuals had portions of their tails missing, probably due to turtles.

The total number of *erythrogaster* observed in Kansas outnumbered its associate *rhombifera* at a ratio of about two to one. In Arkansas, Missouri and Oklahoma *sipedon* outnumbered *erythrogaster* at a ratio of about three to one. Only one *erythrogaster* was found in Texas.

The area studied in Kansas was at the edge of the ranges of both *erythrogaster* and *rhombifera*. The latter species, being more aquatic, is probably not able to tolerate long periods of drought and was therefore rare. As a result of the drought limiting the available habitats to the brooder ponds, the two species were found together, although their habitat preferences appear to differ considerably.

Acknowledgments. The author is indebted to Dr. Herndon G. Dowling, University of Arkansas, who directed this study with unfailing interest; to Dr. Claude W. Hibbard, University of Michigan, for many constructive suggestions for the study in Kansas; to Dr. George A. Moore, Oklahoma A. and M. College, for the identification of some fish; to Dr. Carl E. Hoffman, University of Arkansas, for his valuable criticisms; to T. Bell, Camden, Arkansas, and to Anthony Worth, Plymouth, Michigan, for aid in gathering material.

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A NEW LOCALITY FOR THE LEOPARD FROG IN OREGON.—During July and early August of 1956, the writer encountered an abundance of *Rana pipiens* Schreber in the vicinity of Juntura, Malheur County, Oregon. This is apparently the first record of this species in southeastern Oregon west of the vicinity of Vale, which is 40 miles east and 15 miles north of Juntura. *Rana pretiosa luteiventris* Thompson was also very common in the Juntura area. Both species were found in irrigation ditches and along the shores of the Malheur River.

Since virtually all of southeastern Oregon is desert, and since the only other Oregon records of *R. pipiens* are along the extreme northern boundaries of the state, it is most likely that the Malheur River, which flows westward through Juntura to Vale, was the means by which this species entered the Juntura area. A limited amount of collecting in two widely separated parts of the headwaters of the Malheur River (approximate vicinities of Venator, Harney County, and Seneca, Grant County) revealed an abundance of *R. pretiosa luteiventris* but no *R. pipiens*. This observation considered in connection with the apparent absence of any previous records of *R. pipiens* in the upper Malheur River suggests that the migration of *R. pipiens* into the above region may be a relatively recent occurrence.—*Douglas M. Burns, 2235 N.E. 2 Avenue, Portland 12, Oregon.*

AMPHIBIAN EGGS PRODUCED SINGLY OR IN MASSES.—Keys for identification of amphibian eggs commonly differentiate between groups on the methods of egg deposition. Nevertheless, it has long been known that in several species some females produce single eggs, whereas others lay them in masses (Bishop, Handb. Salamanders, 1943; Wright and Wright, Handb. Frogs and Toads, 1949; Bragg, Proc. Okla. Acad. Sci., 30: 21-24, 1950; Bleakley, Copeia 1957[2]: 141-142). *Ambystoma texanum, A. tigrinum, A. jeffersonianum* and *Bufo punctatus* are examples mentioned by various authors. No one seems to know how much of this is genetic and how much environmental (cf. Bleakley, *loc. cit.*).

The following observations tend to show for the species concerned that, under some conditions at least, it is basically environmental, based primarily upon presence or absence of types of egg supports usually used.

Pairs of *Bufo cognatus, B. w. woodhousei* and *B. terrestris charlesmithi,* mated in nature and confined in aquaria or large glass culture dishes partially filled with water, produced strings of eggs much as they would have done in nature. But under the same conditions, *Pseudacris nigrita triseriata* and *P. s. streckeri* often laid eggs singly, scattered at random on the bottom. One pair of the former, offered a clean bottle brush as the only support for eggs, completely ignored it. Another pair, offered a small twig and two oak leaves, accepted both for small masses of eggs, the remainder being scattered singly. Ten other pairs, given no supports whatever, produced most eggs singly, but in a few cases small clumps of eggs were admixed. Essentially similar results were obtained with several pairs of *P. s. streckeri* and with one pair of *P. clarki.*

Field observations in the spring of 1957 near Norman, Oklahoma, substantiated these laboratory results for other species. Dozens of clutches of eggs of Strecker's spadefoot, *Scaphiopus holbrooki hurteri,* were seen in many pools. In all cases except two they were attached normally in small masses as earlier described (Bragg, Copeia 1944: 230-240; Proc. Okla. Acad. Sci. 30: 18-19, 1950). The two exceptions occurred in adjacent pools, neither of which had any of the types of supports commonly used for eggs. In both, the eggs were found mostly scattered singly on the muddy bottom almost at the water's edge. In one pool I estimated that at least three and probably four pairs had produced eggs during one night, for the pool was completely ringed by eggs. In both pools, a few masses of 10, 12 or up to 25 eggs had been attached to single dead oak-leaves. The eggs in both pools developed normally into healthy tadpoles.

Ambystoma texanum during the same spring produced thousands of eggs in another pool in this same manner, scattered just off the shore line, singly on the mud. Here, however, each egg tended to adhere to the bottom or to whatever happened to be available, such as a very few twigs and individual leaves.

From these observations it would seem that some Amphibia are adaptable, using egg supports when available, but getting along well without them under atypical conditions, sometimes even changing the characteristic egg laying pattern.—*Arthur N. Bragg, Dept. of Zool. and Biological Survey, Univ. of Oklahoma, Norman.*

Sexual Dimorphism in a Population of the Western Diamond-backed Rattlesnake

By DON R. BOYER

Many external taxonomic characters that are fairly uniform in colubrid species are variable in rattlesnakes. Hence a study of variability within and between rattlesnake populations is of interest, particularly in sexually dimorphic characters.

The 214 specimens of *Crotalus atrox* Baird & Girard upon which this study is based were collected during 1938-1942 in the Wichita Mountain Wildlife Refuge in southwestern Oklahoma. The majority was obtained during November 1941 and 1942. All months except February and December are represented. The sample represents a homogeneous, semi-isolated population occurring in a range of low granite and limestone hills surrounded completely by mixed-grass plains (Blair and Hubbell, 1938, Amer. Midl. Nat., 20: 425-454). The series was added in 1950 to the collections of the University of Oklahoma Museum of Zoology.

Sex Ratio: In contrast to other rattlesnake collections (Klauber, 1936, Occ. Pap. San Diego Soc. Nat. Hist., 1:8-13; Woodbury *et al,* 1951, Herpetologica, 7:1-52) the sex ratio in this sample shows a slight preponderance of females (117 to 97). However, this ratio is not significantly[1] different from 50-50. In studying a *C. viridis oreganus* population, Fitch (1949, Amer. Midl. Nat., 41: 513-579) estimated by computation of recapture data that females outnumbered males by 1.2 to one.

Body Proportions: Three measurements were tabulated in comparing body proportions: head length, tail length (to base of rattle) and body length (total length to base of rattle minus head and tail lengths). Body length was more suitable as the independent variable, in comparing body proportions, than the total length since the former contains neither of the dependent variables.

Relative growth of head and tail to the body were best expressed by regression lines corresponding to the familiar $Y = a + bX$ type of equation. In order to determine the presence of sexual dimorphism, the slopes of the male and female regression lines were tested. A test was also made for heterogonic growth by determining the probability that the term "a" in the above equation could take the observed value when $a = 0$ (or unchanging proportions).

Males possess longer tails at all body lengths. The greater average length of males is due not only to longer tails, but also to greater average body length.

Testing ontogenetic differences in tail proportion reveals that males have no significant change with age and females have only a marginally significant change, showing a slight tendency to have relatively shorter

[1]The term "significant" in this paper means that P is .01 or less. The term "marginally significant" means that P is less than .05 but more than .01. Statistical methods were drawn chiefly from Walker and Lev (1953, Statistical Inference).

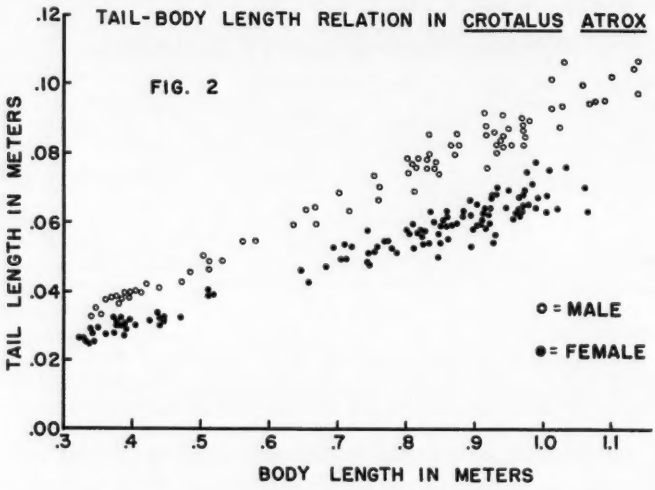

Figure I shows the relation of tail lengths to body lengths. No significant sexual differences were found in head proportions, although the large values of the "a" terms in the regression equations indicate marked ontogenetic changes in both sexes, smaller snakes tending to have proportionally larger heads.

tails with increased body length. Klauber (1943, Bull. Zool. Soc. San Diego, 18:1-60) reports similar findings.

The relation of fang length to head length appears to fit some other types of equations involving exponents, such as those described for rattlesnake fangs by Klauber (1939, Occ. Pap. San Diego Soc. Nat. Hist., 5:1-61). Due to differential wear and age of fangs, fang length may not give a close approximation to true fang-head relation. One might conceivably argue whether or not the fang grows in relation to the body or to the head. A preliminary graphic treatment suggests that sexual dimorphism in this instance is not significant.

Scalation: As in most other crotalid populations, males show significantly fewer ventrals and more caudals (Table 1). The number of caudals in this sample would serve as a criterion separating males from females, since there is no overlap in counts. In larger samples, this method might occasionally break down.

Dorsal scales have been tabulated in the neck, mid-body, and pre-tail regions. Sexual differences are significant in the number of rows at neck, marginally significant at mid-body and not significant at pre-tail region. Male averages were higher where the two differences occurred.

Both upper and lower labials showed marginally significant sexual differences, both in total numbers and on separate sides. However, these did not occur with any consistent pattern and are of negligible importance.

Reference in the literature to sexual dimorphism in head scales of snakes is infrequent. However, in this sample, several related head characters exhibit differences. Nearly twice as many males have but one loreal, this difference proving significant when tested. Another character used in rattlesnake taxonomy, the postnasal-upper preocular contact, seems obviously related to the number of loreals and was tested for dimorphism. The difference was significant, males having this contact type approximately twice as often as females. The number of loreal scales was also found to be significantly correlated with this contact type, larger numbers of loreals tending to prevent contact.

Extra scales were found in the loreal region of some specimens that might be designated as "post-supraloreals" or "postloreals." These were present in eight percent of females and only one percent of males: a marginally significant sexual difference.

The apparent tendency of females to have more head scales suggested testing another contact type, the prenasal—1st upper labial, contact being prevented most frequently by a group of scales sometimes referred to as "foveals." Dimorphism in the occurrence of this contact type was much less than in the preceding two, yet nevertheless was significant, the males having more contacts (*i.e.* fewer interrupting scales).

For most characters investigated, juvenile (less than 700 mm. total length) and adult snakes were separately tabulated and tested to determine ontogenetic changes in scalation. No change was apparent in any of the characters tested.

TABLE 1

Summary of tests of differences in means of characters of male and female *Crotalus atrox* from Comanche County, Oklahoma.

Character	Sex	Range	Mean and S.E.	Coeff. of D.[1]	P
Ventrals	♂	174-189	181.45 ± .28	-1.8%	.0001-
	♀	179-193	184.74 ± .26		
Caudals	♂	24-29	26.17 ± .12	25.4%	.00001-
	♀	18-23	20.27 ± .11		
Dorsal rows					
Neck	♂	25-30	27.17 ± .11	2.6%	.001
	♀	23-30	26.47 ± .12		
Mid-Body	♂	25-27	25.63 ± .09	1.2%	.018
	♀	23-27	25.33 ± .07		
Pre-Tail	♂	19-24	21.60 ± .10	0.1%	.57
	♀	19-25	21.59 ± .10		
Upper labials	♂	26-34	30.29 ± .14	−1.6%	.016
(total)	♀	27-34	30.78 ± .15		
Lower labials	♂	31-38	34.10 ± .15	1.5%	.022
(total)	♀	29-37	33.61 ± .15		
Body blotches	♂	30-39	34.96 ± .18	0.2%	.78
	♀	28-41	35.03 ± .19		
Tail rings	♂	4-7	5.62 ± .07	28.2%	.0005-
	♀	3-6	4.23 ± .04		

[1]A negative coefficient of divergence indicates female value is greater.

TABLE 2

Summary of tests for sexual dimorphism in selected correlations in a population of *Crotalus atrox*.

Ventral-Caudal correlation

Sex	r	P (Test r=0)	P (Test $r_1=r_2$)
♂	.354	.0005	.0005-
♀	—.305	.0005	

Ventral-Body blotch correlation

Sex	r	P (Test r=0)	P (Test $r_1=r_2$)
♂	.257	.005-	.11
♀	.093	.15+	

Tail ring-Caudal correlation

Sex	r	P (Test r=0)	P (Test $r_1=r_2$)
♂	.875	.001-	.001-
♀	.603	.001-	

Body blotch-Tail ring correlation

Sex	r	P (Test r=0)	P (Test $r_1=r_2$)
♂	.933	.001-	.001-
♀	.130	.07	

Body Markings: The number of tail rings in males was significantly higher, showing an obvious relation to the longer tail (Table I). No difference was revealed by testing means of numbers of body blotches of males and females.

Amount of Dimorphism: The relative amount of sexual dimorphism in each character in Table I is indicated by the coefficient of divergence in percent.

Correlations: Computation of the correlation coefficient for the number of ventrals and caudals revealed sexual dimorphism—males showed a positive correlation and females a negative one (Table 2). This indicated that males with more ventrals would tend to have more caudals, whereas females with more ventrals would tend to have fewer caudals. Values for "r" were not particularly high, but were significantly different from zero when tested. Both correlation coefficients for this character are higher than any reported by Klauber (1945, Bull, Zool. Soc. San Diego, 21: 1-101) for several other crotalid species.

Both males and females showed a positive correlation between number of tail rings and caudals, but the male coefficient was significantly higher. Males exhibited a slight, positive correlation between body blotches and ventrals, whereas the corresponding value for females was not significantly different from zero. The correlation between the number of body blotches and tail rings was also tested. Males had a high, positive correlation between these characters, but females showed none. These latter three types of correlations are consistent with the findings of Klauber (1945, *op. cit.*).

DISCUSSION

Many sexual differences in rattlesnakes are based on morphology associated with reproduction. The larger proportions of the male tail seem obviously correlated with a greater number of tail rings and caudals, whereas the greater number of ventrals in the female may be related to the function of the female body as a retainer for the developing young.

Some scale characters such as the number of loreals, dorsal rows at neck and others which show statistically significant differences in the sexes are difficult to visualize as adaptively important. Most are probably merely characters hormonally influenced at the time of scale formation or are differences related to genes located on sex chromosomes. Whatever their basis, these sexual differences in rattlesnake characters should be taken into consideration when dealing with problems of geographic variation.

SUMMARY

Selected characters in a series of 214 specimens of *Crotalus atrox* from Comanche County, Oklahoma, were studied to determine the extent of sexual dimorphism. Tails of males were markedly longer at all sizes, whereas head lengths were similar. Ventrals, caudals, loreals, anterior dorsal scale rows and tail rings showed significant differences. Several correlations of scale counts with body markings exhibited sexual dimorphism.

DEPT. ZOOLOGY, TULANE UNIVERSITY, NEW ORLEANS

HOMING BY A SQUIRREL TREEFROG, *HYLA SQUIRELLA* LATREILLE.—Homing has been defined as the return of an animal to a given locality, following removal by man or by some environmental accident. However, the term may also be used to indicate return to a precise spot, following normal wanderings such as those involved in the search for food. I once had opportunity to observe the homing (in the latter sense) of a squirrel treefrog, *Hyla squirella* Latreille. The observations were made on a tract known as "The Hammock," the property of Ross Allen, on the western outskirts of Silver Springs, Marion County, Florida.

About 8:30 a.m. on a bright summer morning, I found a female *Hyla squirella* on the door of an abandoned shed near my house. It had wedged itself into a crack between the top of the door and the lintel. It was the largest squirrel treefrog I had seen, and had flattened itself remarkably in order to occupy the narrow chink. At intervals during the day I investigated the hiding place; the frog had not moved. Evidently it remained in its retreat throughout the entire day. About an hour after nighfall, however, it appeared on the screen of my kitchen window and remained there, or on the window sill, for about two hours. During this time it stalked and sometimes caught small insects that had been attracted by the kitchen light. I felt sure that the frog foraging on the screen was the

same one I had seen resting on the door; its large size precluded the likelihood of a misidentification. Furthermore, the niche above the door was now empty, and with a flashlight, I could locate no other squirrel treefrog in the vicinity.

During the following 16 days, this frog was present in the crack above the shed door all through the hours of sunlight, but absent therefrom throughout the nights. It would visit the kitchen window on two and sometimes three successive nights, then would skip a night. I did not learn its whereabouts on those nights when it did not come to the lighted window, or where it went after spending an hour or two on the screen. Certainly it did not go "home," for I examined the niche above the shed door at various hours of the night and never found the frog to be there. It is likely that the window was just a small portion of the area over which the amphibian customarily foraged.

On the morning of the 18th day, the frog was not to be found in its usual hiding place; and I saw no more of it, by day or by night, until midmorning of the 23rd day, when by chance I found it in a new retreat. It was beneath the metal cover of a large cylinder of "bottled" gas, beside my house. There were two small male *Hyla squirella* and a male *H. femoralis* Latreille hiding beneath the same cover. (I do not mean to imply that the sex of the frogs had anything to do with the aggregation.) That night the large female reappeared for a time at the lighted window.

For 15 days thereafter, the frog seemed to follow its usual routine of nightly foraging, appearing on the screen for two or three successive nights, then skipping a night. It spent the sunlight hours of the 23rd, 24th, 25th, 26th, 28th, 29th, 32nd, 36th, 37th and 38th days in its new home beneath the cylinder cover, but those of the 27th, 30th, 31st, 33rd, 34th and 35th days in the old home atop the shed door. On the morning of the 39th day, the frog was not in either of its retreats, and I never saw it again.

In summary: This squirrel treefrog had a definite home, to which it could and would return after about 10½ hours absence during the night. For a time it had two homes, aproximately 43 feet apart. It frequently foraged in an area (the kitchen window) roughly midway between the two. Evidently it could orient itself in three dimensions, for, in order to reach the window from the top of the shed door, it had to descend to the ground, cross at least 12 feet of open sand, and then climb the side of the house. The activity range of this individual occupied a considerable volume of space even if it did not venture beyond the points where it was observed. Actually, there was indirect evidence that it foraged in areas other than those in which it was seen. In an hour or two at the lighted window it could stuff itself with insects, yet it did not return home when replete but instead waited until morning. This circumstance suggests that visual cues may have been important in orientation.—Wilfred T. Neill, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

A High Crested Race of Toad (*Bufo valliceps*) and Other Noteworthy Reptiles and Amphibians From Southern Mexico

By I. Lester Firschein and Hobart M. Smith

Among specimens secured by Dr. Clarence J. Goodnight in 1949 are a number of reptiles and amphibians that contribute materially to the knowledge of the herpetofauna of southern Mexico. Included are examples of an unnamed, high-crested race of *Bufo valliceps,* some specimens of which Smith secured at the same locality ten years before. Others were obtained for us by Mr. Thomas MacDougall and both lots are herein reported with the noteworthy Goodnight specimens. All are now in the University of Illinois Museum of Natural History, to which all numbers cited refer.

We are much indebted to both Mr. Thomas MacDougall and Dr. C. J. Goodnight for their kindness, often under extremely difficult conditions, in preserving and forwarding the collections on which these notes are based.

Bufo horribilis Wiegmann. Three juveniles (Nos. 11305-7) are from a cocoanut plantation at Touloum, Quintana Roo (Aug. 12), and one (No. 11304) from Chancanah, Cozumel Island, Quintana Roo (Aug. 8.) The species has not been reported before from the state.

Bufo valliceps macrocristatus subsp. nov.

Holotype Univ. Ill. Mus. Nat. Hist. No. 35583, March 24-26, 1950, between La Gloria and Cerro Azul (presumably nearer Cerro Azul), Oaxaca, Thomas MacDougall. *Paratypes* seven, including Nos. 35584-6, mountains between La Gloria and Juchitán, Oaxaca, Jan. 11 and 16, 1950, Thomas MacDougall; 11308-9, 11311, 14388, Ruins of Palenque, Chiapas, July 7, 1949, Dr. C. J. Goodnight, and July 4, 1939, H. M. Smith. *Hypoparatypes* nineteen, including 11310, 11312-21, 14381-7, all juveniles from the ruins of Palenque.

Diagnosis. Closely related to *Bufo v. valliceps,* differing as follows: cranial crests hypertrophied, although pretympanic, preocular and subocular crests often absent; skin more spinose, above and below; tympanum smaller, vertical diameter often equalling tympanorictal distance, horizontal diameter equalling orbitotympanic distance; dorsolateral tubercles more prominent, protuberant; prefrontal crests more often straight, less often concave; belly more darkly pigmented; often prominent black marks on dorsum.

Description of holotype. A subadult female 62 mm. snout-vent; interorbital, prefrontal and parietal crests forming a continuous ridge reaching maximum height of 4 mm. at rear corner of orbit; supratympanic crest ¾ length of postorbital; pretympanic crest poorly defined; antorbital crest low; suborbital crest low, rounded, scarcely evident; prefrontal crests nearly straight, not concave. Tympanum small, 3.2 x 5 in diameter, 3.7 from corner of eye, 5.4 from corner of mouth. Maximum depth of head 8.5, width 25.5, length to rear of tympanus 20; parotoids 11 x 5.8, separated by 12.5; a dorsolateral series of protuberant, spinose tubercles 1-1.5 long, extending from within parotoids to groin; venter and limbs

profusely spinose. Fingers not webbed, first longer than second; subarticular tubercles mostly simple, paired under distal joint of third finger; a large oval palmar tubercle; a well developed thenar pad. Toes webbed, formula 1.5-2.5, 1.5-3, 2-3.8, 3.8-2; an outer metatarsal tubercle, half size of inner. A narrow, dark interorbital line; a pair of prominent, oval inter-scapular dark spots; vertebral light line dimly evident; a single dark spot on one side of lumbar region; venter coarsely reticulated with dark brown on belly and limbs.

Variation. The three paratypes from Oaxaca agree with the type in diagnostic features, having a spinose skin, protuberant dorsolateral spines, small tympanum, dark venter and hypertrophied crests. Two have a prominent vertebral light stripe, distinctive in being bordered by an irregular black line; the other lacks a stripe. All three have irregularly arranged prominent black marks above. One, larger than the type (75 mm. snout-vent), has crests equally as large as the type; in the other two, both smaller (50 and 58 mm. snout-vent), the crests are smaller, but not directly correlated with size (3.5 and 2, resp.).

The series from Palenque possesses all essential features of the Oaxaca series although other variations are introduced. The dark belly, spinosity and ridge hypertrophy are constant, but the black dorsal marks are very small or absent in 7 of the series of 23. The vertebral light stripe is prominent in only two of the four adults. Ridge hypertrophy is clearly evident even in juveniles as small as 23 mm., at which size the ridges are scarcely evident in specimens of typical *valliceps* from the nearby village of Palenque.

Comparisons. Juveniles of this subspecies are readily recognizable by the darkly pigmented belly and early appearance of cranial crests.

Adults are most strikingly different from typical *valliceps* in the hypertrophy of the cranial crests. Other less striking but apparently equally valid differences exist in belly pigmentation, spinosity and small tympanum. Some of these characters are separately matched by occasional specimens of *valliceps* from various parts of its range, except for the crest character which seems to be unique.

The race is widely different from the somewhat similar *cavifrons* and *cristatus* in the absence or relatively poor development of the parietal crests, although all are similar in small size of tympanum.

Firschein (Copeia, 1950: 83) has shown that *"B. cristatus"* of Taylor and Smith is not Wiegmann's species originally designated *cristatus*. The present subspecies *B. v. macrocristatus* is one of the two forms stated by Firschein to be represented among specimens erroneously referred by Taylor and Smith to *cristatus*. We are not at present prepared to segregate taxonomically the other form, occurring in upland regions of central Veracruz and in parts of southern Chiapas. It resembles *valliceps* in the characteristics diagnostic of *macrocristatus*.

Range. Typical specimens of *valliceps* have been examined from the Pacific slope of Chiapas in the vicinity of Acacoyagua and from the Atlantic slope in the upper valley of the Río Grijalva (Tuxtla Gutierrez) and the forested hills of Piedras Negras, Petén, Guatemala. Essentially typical specimens have been examined from the modern village of

Palenque situated on the savanna only one to two miles from the forested foothills where the ruins are located.

Specimens from the ruins of Palenque are somewhat variable, especially in degree of hypertrophy of the crests, one example being little different from the extremes occurring in *valliceps*. Furthermore a specimen from Tenosique, Tabasco, resembles *macrocristatus* in spinosity and pigmentation. This locality is at the edge of the forested foothills.

Present evidence suggests that the *valliceps* population of the forested sierra on Atlantic slopes, from the Isthmus of Tehuantepec toward the Guatemalan border and probably into that country, is occupied by *macrocristatus*, which appears to intergrade with *valliceps* along the areas of junction of savanna or lowlands and the hills of the sierra. A habitat difference seems evident in this distributional picture. However, in other areas, e.g. Veracruz and Pacific Chiapas, the habitats of presumably typical *valliceps* embrace both types of habitat occupied separately in northern Chiapas by *valliceps* and *macrocristatus*.

Leptodactylys melanonotus (Hallowell). One is from a cenote at Touloum, Quintana Roo, Aug. 12. Ventral surface heavily reticulated with black, presenting a much darker appearance than specimens from Veracruz on the edge of the Mexican plateau. At least two geographic races appear to exist in this area.

The species has not previously been reported from Quintana Roo, although its occurrence was to have been expected.

Centrolenella fleischmanni (Boettger). Two (Nos. 11302-3) from the Ruins of Palenque, Chiapas, July 4. Field notes record that in life one is "yellowish-green dorsally, pale green ventrally; toes yellow; a yellow spot above eye; dropped eggs from branches overhanging stream."

Markings as previously described for this species, which has not heretofore been recorded from the Atlantic slope of Chiapas. Records for Petén and southern Guatemala suggest the species has a crescent-shaped range in Central America, the localities in northern and southern Chiapas constituting the horns.

Rhadinaea decorata decorata (Günther). A male, Palenque Ruins, Chiapas, July 4, W. T. Rockhold; unusual in having the nuchal and dorsolateral light lines joined, paralleling the condition described for *Rhadinaea decorata ignita*, a perhaps poorly defined geographic race in Panamá and Colombia. Presumably the distinctness of nuchal stripes is a genetically variable feature in *decorata*, although this is the only example possessing the joined condition among about 50 Mexican specimens seen. It has been questioned whether the united condition is equally as constant in a geographically parapatric area in the southern part of the range of the species as the separated condition is in Mexico. The present specimen strongly indicates that the character is not an infallible index of either specific or subspecific rank in this group.

Ventrals 116; caudals 124; rows 17-17-17; lateral dark stripe on fifth row; 24 plus 2 maxillary teeth; body/tail ratio 86%; supralabials 8-8, fourth and fifth entering orbit; infralabials 10-10, 6 in contact with chinshields, 5 with anterior and 3 with posterior; nasals divided; oculars 1-2; supra-anal keels present; hemipenis 8 caudals long, sulcus forking opposite 6th caudal, tip capitate, calyculate. Total length 310; tail 144.

Paravertebral region light brown at mid-body and posteriorly, barely distinguishable from a faint darker stripe occupying center of vertebral (9th) row; lateral row (8th) to each side of vertebral stripe lighter brown, scales lateral to this light buff; anterior third of body with paravertebral and vertebral regions much darker than at mid-body; anteriorly, outer edges of paravertebral area marked by distinct black stripe following boundary between 6th and 7th rows; posterior to anterior third of body this stripe becoming indistinct and fading into light paravertebral area; white stripe on upper 5th and lower 6th rows, posteriorly joining the light paravertebral region, anteriorly diverging at nape and separated from temporal bar by a single scale, constituting the only break in the light lateral line; dorsolateral dark stripe below light paravertebral region ocupying lower portion of 5th row; area lateral to this dark on nape and progressively lightening posteriorly, about same shade as median stripe at mid-body; anteriorly, another dark narrow stripe on upper 3rd of first row and lower 3rd of second, fading out a short distance behind anterior third of body; lateral to this area a white stripe on lower two-thirds of first row; anteriorly and posteriorly this area finely mottled with light pigment; lateral area of each ventral scale finely pigmented; small dark blotch on each ventral where it meets the 1st dorsal scale, forming a broken lateral line; venter otherwise immaculate; tail and posterior part of body marked somewhat differently: lateral light area on 1st scale row replaced by heavy mottling; upper ventral blotches broad, forming continuous longitudinal line toward tail tip; dark line on rows 6-7 heavy and distinct, area below forming a broad dark brown band.

Head light tan; parietals moderately pigmented, frontal and anterior head plates sparsely pigmented; a light-centered, dark-edged temporal bar passing from eye through upper postocular and lower border of parietal, separated from nape stripe by first postparietal scale; lateral dark stripe on upper part of 1st scale row continuous onto head as upper supralabial stripe, becoming somewhat indistinct on anterior supralabials; lower edge of supralabials and infralabials white; loreal region brown, bounded above and below by narrow darker areas; brown of loreal area continuous around snout as a very light stripe on upper part of rostral.

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ERRATUM.—Vol. 13, Part 1, page 33, paragraph 3, line 6, read "Izucar de Matamoros; *Enyaliosaurus quinquecarinatus* (Gray), No." instead of "Loveridge, No. 39623, Atencingo, Ficimia publia Cope, No."

A New Lizard of the Genus *Lepidophyma* from Volcan San Martín Pajapan, Veracruz

By JOHN E. WERLER

In a small collection of reptiles and amphibians secured on Volcán San Martín Pajapan during September, 1954, by Tom Bishop and the author, is a specimen of the genus *Lepidophyma* that apparently represents an undescribed population. This, the second recently-discovered member of the genus from the Tuxtlas range of southern Veracruz, adds another form to the rapidly growing list of novelties from that region.

I am indebted to Edward H. Taylor, University of Kansas, who made available for comparison photographs of a related form of *Lepidophyma* and to Jay M. Savage, Pomona College, for providing a copy of his proposed revision of the scale terminology for the family *Xantusidae*.

Lepidophyma pajapanensis sp. nov.

Holotype. Chicago Natural History Museum No. 78382, an adult male from the southeast slopes of Volcán San Martín Pajapan, Veracruz, Mexico; elevation 3,500 feet; collected by Tom Bishop and John E. Werler September 18, 1954.

Diagnosis. A species of *Lepidophyma* differing from other described forms (except *tuxtlae*) in having the enlarged tubercles of each paravertebral row contiguous and subequal and from all in having two outer rows between paravertebral series enlarged and keeled. Additional differences between the new species and other known forms are given in the "comparisons."

Description of holotype. Head and body somewhat flattened. Rostral plate easily visible from above; anterior nasals wider than high, in contact medially behind rostral; a large median frontonasal (with a superficial longitudinal groove) in contact with nasals, anterior loreals and prefrontals; paired prefrontals separated by a median scale, the latter transversely divided into two parts, the larger part about four times greater than the smaller; a pair of frontals between orbits, followed by paired parietals and a longer, hexagonal interparietal; these scales in turn preceding two large postparietals; three enlarged upper temporals laterally adjoining posterior head scales; anterior upper temporal smallest, separated from sixth upper labial by a still smaller, lower anterior temporal; median upper temporal largest, about two-thirds size of a postparietal; posterior temporal twice size of first upper.

Nostril pierced between first labial and two nasals; postnasal smaller and slightly lower than anterior loreal, higher than anterior nasal, in contact with frontonasal; two loreals, anterior higher than broad, widest at base, posterior approximately twice as large as anterior, about as wide as high; a small triangular loreolabial above fourth supralabial; ocular ring of three pre-, two sub- and four postoculars; supralabials seven, fifth larger than preceding four, entering orbit; sixth the largest, in broad contact with lower anterior temporal; seventh much smaller than sixth; pretympanics granular, nearly subequal, except for several larger scales that

border median temporal; forward extension of pretympanic area separating secondary temporal from lower anterior temporal and sixth and seventh supralabials; a row of small protuberant auricular lobules at anterior border of ear.

Mental large; three pairs of large infralabials, first pair forming a median suture, second pair narrowly separated medially, third pair widely separated; a number of smaller postlabials; pregulars rounded, relatively large, about eight near middle of throat in vertical diameter of ear opening; gulars small, transversely elongate; a pair of parallel, longitudinal folds on either side of neck; neck with pointed, angular tubercles, variable in size.

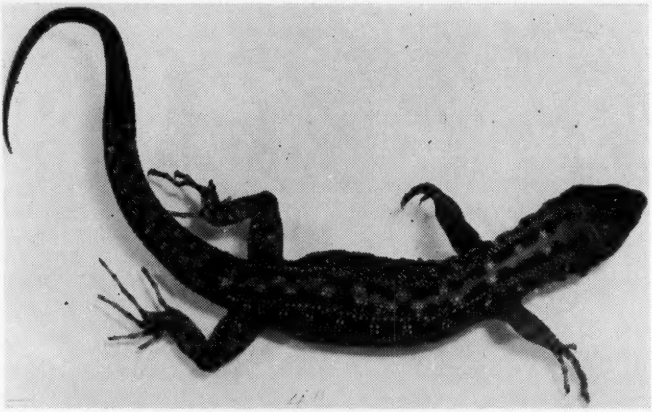


Plate 1. *Lepidophyma pajapanensis,* holotype, CNHM No. 78382; Volcán San Martín Pajapan, Veracruz, Mexico.

Body scales heterogeneous; two paravertebral rows of enlarged trihedral tubercles, the scales of each series in an uninterrupted row, each tubercle touching every adjacent one; about 45 scales in a paravertebral row between axilla and groin; a row of similar, but smaller tubercles separating each paravertebral row from middorsal granules; vertebral band of small granules two granules wide. Dorsolateral scales heterogeneous, some equal to or slightly larger than those in the paravertebral rows, others conical and intermediate in size, some small and granular; larger scales mostly trihedral, a few conical and seemingly arranged in two or three parallel longitudinal rows, separated from one another by smaller scales and granules; laterally the angular scales mostly giving way to conical tubercles, intervening granules few; ventrolateral surfaces with only small conical scales, intervening granules absent.

Venter with large plates arranged in thirty-eight rows from gular fold to vent, in thirty rows from axilla to groin and in ten transverse rows at middle of abdomen, outer rows with trace of a keel; two pairs of large, squarish preanals, a much smaller scale laterally adjoining each scale of

the first pair; posterior pair a little larger and bordered on either side by a scale about half as large.

Scales on forearm ovoid and keeled, with little variation in size; radials larger, subimbricate; scales on ventral surface of foreleg slightly smaller, ovoid. Hind limbs with assorted angular and conical scales; femorals large, keeled, subimbricate, nearly subequal; tibials differentiated, consisting of small tubercles interspersed among larger keeled scales; scales on ventral surfaces of hind limbs more pavimentous, smooth, little differentiated. Femoral pores 16-17 in a row; subdigital lamellar formula of manus 9-14-18-17-16; of pes 10-16-19-30-20.

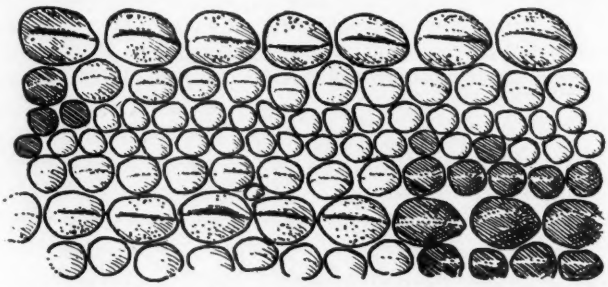


Figure 1. Middorsal scales of *Lepidophyma pajapanensis,* holotype. Drawing by Donald L. Smith.

Tail with whorls of large scales, heavily keeled dorsally and laterally, smooth ventrally; distal half of tail regenerated; enlarged whorls on basal half of tail enclosing three rows of smaller scales dorsally, one less ventrally.

Color in preservative: Dorsal surfaces of body and tail dark gray; head generally light brown; a dark suffused spot on each frontal; rostral, anterior nasals and first labials black; upper labials, center of mental and of infralabials black with dark pigment over most of remaining portions of these scales; some dark pigment in pretympanic region; dorsum bearing small rectangular dark spots with irregular edges, arranged roughly in two paravertebral rows; a dorsolateral row of slightly larger black rectangular spots on either side of body, markings on neck coalesced, those near tail indistinct; vertebral region nearly unmarked; irregular small dark spots along sides from lateral fold to venter. Dark pigment scattered over throat; venter generally light; each ventral plate with dark pigment on anterior and generally on lateral surfaces; a few plates with a bold black spot on anterior edge; irregular light and dark markings on unregenerated portion of tail; irregular small dark spots scattered over limbs.

Snout to vent, 74.0 mm.; tail, 90.8 (regenerated); axilla to groin, 30.6; head length to ear, 17.5; head width, 12.2; head depth, 9.0; length of foreleg, 23.2; hind leg, 31.4.

Comparisons. The relationships of this form to other known species are not clear. From *tuxtlae,* with which it occurs on Volcán San Martín Pajapan, it differs conspicuously in color and marking—the former possessing light, circular spots on a dark ground color; the latter, dark rectangular spots on a light ground color; in a higher femoral pore count and absence of enlarged trihedral tubercles along lower sides of body. In the last character the new species is similar to *micropholis* and *sylvaticum,* differing from both in possession of a median head scale and in having the sixth supralabial larger than seventh. From *micropholis* it is distinguished also by fewer scale rows around body, fewer rows between paravertebral series, by median contact of only one pair of infralabials and by three instead of four rows of small scales between enlarged caudal whorls. It has more femoral pores than *sylvaticum.* Compared with *reticulatum, pajapanensis* differs in the absence of enlarged tubercles along lower sides of body, in the presence of a median head scale, in having three instead of four rows of smaller scales between enlarged caudal whorls and gray instead of black ground color. From *ophiophthalmum* it differs in absence of enlarged trihedral tubercles along lower sides of body, in lack of contact of second infralabials, in having three instead of four rows between enlarged caudal whorls, in first loreal—posterior nasal sizes and in possession of gray instead of black ground color. From *tenebrarum* by absence of enlarged tubercles on lower sides of body, by a median head scale, by the sixth supralabial larger than the seventh and by lack of contact between seventh supralabial and lower anterior temporal. From the other subspecies of *flavimaculatum* (as defined by Walker, 1955, Occ. Papers Mus. Zool. Univ. Michigan, 564: 1-10) it differs conspicuously in lacking enlarged tubercles along lower sides of body. From *smithi, tehuanae* and *occulor* in higher femoral pore count, from the last two in the presence of a median head scale and from the first in contact of only one pair of infralabials. *L. f. flavimaculatum* and *obscurum* have more scale rows between paravertebrals than *pajapanensis.*

HOUSTON ZOOLOGICAL GARDENS, HOUSTON, TEXAS

A Contribution to the Herpetofauna of the Highlands of Oaxaca and Puebla, Mexico

By FREDERICK R. GEHLBACH and BRUCE B. COLLETTE

The southeastern highlands of Mexico, including parts of the states of Oaxaca and Puebla, have long been of interest biogeographically. This area with its high interior plains and great mountains lies within the Transverse Volcanic and Sierra Madre del Sur Biotic Provinces of Goldman and Moore (1945, Jour. Mamm., 26: 347-360). Here xeric grasslands, pine-oak woodlands, and humid mountain cloud forests each contain their respective faunal elements. From August 10-27, 1954, a Cornell University ornithological field party assembled, in addition to birds, a noteworthy collection of the highlands herpetofauna.

The specimens were collected at four localities. La Cumbre, five miles northeast of Cerro San Felipe, Oaxaca, elevation 9000 feet, is in an area of sharp relief. Most of the land is now under cultivation, but the original cover was, as indicated by a few remaining stands, mixed pine-oak and fir with some madrones and other secondary forms. Fence rows and chaparral-covered hillsides are prominent. The country two miles east of Tlaxiaco, Oaxaca, 7800 feet, supports a thin stand of pines with many limestone outcrops and some grass, cacti, and agaves. In the immediate vicinity of a creek *Bufo occidentalis, Rana palmipes* and *Thamnophis scalaris* were the principal exothermic vertebrates. Four miles west of Zoquitlán, Puebla, 8400 feet, is typical of the mountain highlands with steep ravines and sharp ridges. On the west slopes vegetation is largely pine-oak whereas the eastern exposures support a more mesic environment of oaks heavy with moss and epiphytes. Dirt roads lined with pumice follow the ridge tops. The region ten miles southeast of Mount Malinche, Puebla, 8100 feet, is on plateau level. Thick oak scrub and corn fields dominate the landscape.

Material upon which this study is based includes 20 known forms (species and subspecies), a total of 170 specimens. The following represent new state records: *Rhadinaea vittata* from Puebla, and *Sceloporus spinosus spinosus, Toluca lineata acuta,* and *Salvadora intermedia richardi* from Oaxaca. In addition to other important specimens discussed hereafter, locality records may be noted as follows: *Rana palmipes* Spix, *Rana pipiens* Schreber, *Anolis nebuloides* Bocourt, *Anolis nebulosus* (Wiegmann), *Sceloporus grammicus microlepidotus* Wiegmann, *Sceloporus formosus formosus* Wiegmann, *Thamnophis scalaris godmani* (Günther), *Thamnophis cyrtopsis cyclides* Cope, all 2 mi. E Tlaxiaco, Oaxaca; *Microbatrachylus oaxacae* Taylor, *Sceloporus f. formosus, Sceloporus mucronatus omiltemanus,* La Cumbre, Oaxaca; *Sceloporus g. microlepidotus, Sceloporus f. formosus, Eumeces brevirostris* (Günther), 4 mi. W Zoquitlán, Puebla; and *Hyla eximia* Baird, 10 mi. SE Mt. Malinche, Puebla.

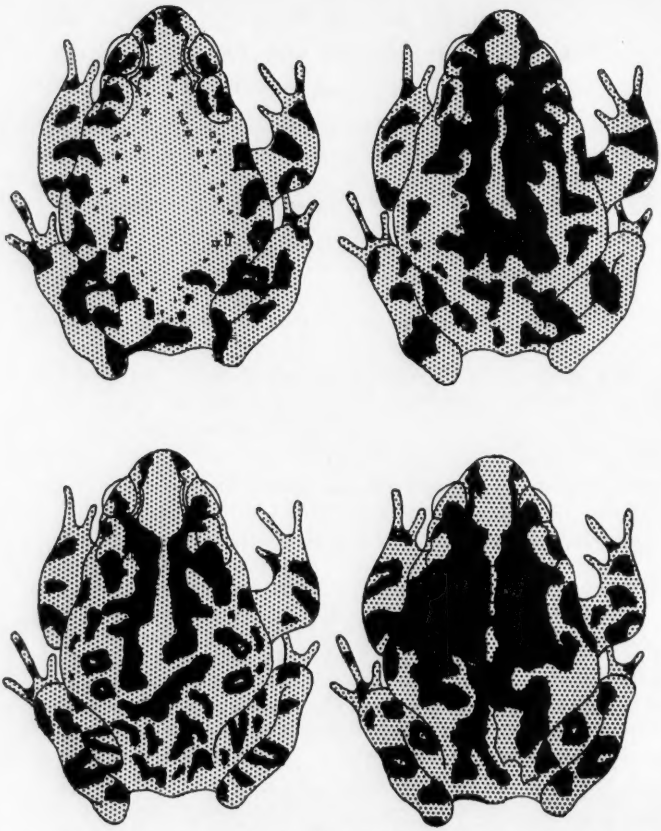


Fig 1. Representative color-patterns in adult *Bufo occidentalis* 2 mi. E. Tlaxiaco, Oaxaca.

Most of the specimens have been deposited in the Cornell University Herpetological Collection to which the catalog numbers cited refer. A few are in the University of Illinois Museum of Natural History. The procedure employed in measuring anurans is that of Cochran (1955, Bull. U. S. Nat. Mus., 206: xiv); for the lizards we have followed Smith (1939, Zool. Ser. Field Mus. Nat. Hist., 26: 23-28). Lamellae counts were made from the fourth toe of the right hind foot. All measurements are in millimeters.

We would like to thank Drs. Hobart M. Smith, Edward H. Taylor and Laurence M. Klauber for help in the identification of certain specimens; and Dr. William J. Hamilton Jr. for review of the manuscript.

TABLE I

Morphometric variation in *Bufo occidentalis* 2 mi. E. Tlaxiaco. Oaxaca. Measurements are expressed as per cent of snout-vent length.

	Head Length	Head Width	Femur Length	Tibia Length	Foot Length
		28 Adult Males			
range	23.2-26.2	32.9-38.7	36.5-41.7	32.1-42.1	37.9-45.2
±	24.6	35.8	40.0	32.7	41.4
		11 Adult Females			
range	21.7-26.0	33.1-37.0	35.3-41.1	31.1-34.8	35.9-42.3
±	22.9	35.3	37.9	35.5	39.0
		39 Combined Sample			
range	21.7-26.2	32.9-38.7	35.3-41.7	31.1-42.1	35.9-45.2
±	24.2	35.6	38.7	34.7	40.6

Bufo occidentalis Camerano. Seventy, 2 mi. E. Tlaxiaco, Oaxaca (5528, 5530-33), 40 adults (determined by gonad maturation), 30 juveniles. The color-pattern is not constant (Fig. 1). Juveniles exhibit a more broken dorsal pattern and dark ventral spotting which adults generally lack. The upperparts are light gray to cream-white, marbled with chocolate brown or black. Only one juvenile has a readily discernible external tympanum whereas in adults the tympanum is easily seen in 40% (16), barely evident in 17.5% (7), and covered by granular skin in 42.5% (17). Morphometric variation is represented in Table 1. Snout-vent in adults 58.0-90.0 (±77.8); adult males, 58.0-86.5 (76.3); adult females, 69.0-90.0 (81.7); juveniles, 29.0-53.0 (40.3). Adult females are generally longer, but smaller than males in other measurements except relative tibia length (Table 1). All adults are in breeding condition; the females contain eggs 1.0-1.5 mm. in diameter.

Abronia oaxacae (Gunther). La Cumbre, 5 mi. NE Cerro San Felipe, Oaxaca (4977). This adult female is the third recorded specimen of the form. Aside from the following details, the lizard fits a description of this species by Tihen (1954, Am. Mus. Nat. Hist., Nov., 1687: 2). Snout-vent, 116.5; snout-ear, 25.0; head width, 20.0; lateral supraoculars, 4; superciliaries, 5; postrostrals, 2; scales across nape, 4; dorsals 29 transversely, 14 longitudinally; ventrals, 14 longitudinally; caudal whorls, 89; lamellae, 20. Dorsal coloration uniform olive brown; osteoderms only moderately developed on head and neck, completely lacking posteriorly. Ventral coloration gray-white with numerous gray spots, these somewhat randomly scattered on first and second dorsal scale rows.

Scutellation and coloration are suggestive of specific relationship with *Abronia taeniata*, of which this gerrhonotine may be but a southern race.

Ameiva undulata undulata (Wiegmann). One, 2 mi. E Tlaxiaco, Oaxaca (4975), an adult female from open pine woods with scattered bunch grass, showing intergradation with the neighboring race, *dextra*. Snout-vent 91.0 mm.; snout-ear, 24.0; femoral pores, 14-14; lamellae, 31; preanal rows, 6, last divided; no enlarged median gular scales. Markings on sides between axilla and groin well-defined white bars bordered by black; dorsal rows of spots indistinct.

Sceloporus spinosus spinosus Wiegmann. Forty-three, 2 mi. E Tlaxiaco, Oaxaca (557-78), in close association with *Sceloporus mucronatus omiltemanus* around limestone outcrops and fallen pine logs. Collecting over a three day period produced, in addition to the *spinosus,* 68 *S. mucronatus* and one *S. formosus* in a ten-acre area. This may give a rough approximation of relative population densities. Meristic variation is given in Table 2. Femoral pore and supraocular counts overlap those of the southern geographic race, *S. s. caeruleopunctatus,* whereas other scale characteristics indicate that this is the typical form. Females snout-vent 63.5-91.0 (±76.6), snout-ear 14.5-20.5 (16.6); males snout-vent 41.0-94.0 (79.5), snout-ear 15.5-21.5 (18.5).

Sceloporus mucronatus omiltemanus (Gunther). Sixty-eight, 2 mi. E Tlaxiaco, Oaxaca (4970-71). Adult males (17), snout-vent 77.0-101.5 (± 91.1), snout-ear 18.0-24.0 (21.8); juvenile males (11), snout-vent 42.0-59.0 (53.3), snout-ear, 12.0-15.0 (13.5); adult females (26), snout-vent 70.0-96.5 (81.4), snout-ear 16.0-24.0 (19.0); juvenile females (14), snout-vent, 39.0-62.0 (50.2), snout-ear, 11.0-15.5 (12.7); data on scutellation in Table 2.

TABLE II

Meristic Variation in *Sceloporus* 2 mi. E Tlaxiaco, Oaxaca.

	Dorsal Scales	Scales Around Body	Femoral Pores R. Leg	Lamellae 4th Toe R. Foot	Supra-oculars
		68 *S. mucronatus omiltemanus*			
range	30-38	36-44	11-16	20-25	——
±	33.5	39.8	13.6	21.4	——
SD.	1.94	1.83	0.42	2.88	——
SE.	0.24	0.22	0.05	0.34	——
		43 *S. spinosus spinosus*			
range	27-31	34-38	6-11	20-24	4-6
±	29.2	36.1	8.65	21.3	4.65
SD.	1.02	1.39	1.25	1.08	——
SE.	0.16	0.21	0.19	0.16	——

Rhadinaea vittata (Jan). Two, 4 mi. W Zoquitlán, Puebla (4966), under flat stones in dry pine-oak woods. Data for the female and male respectively: snout-vent 290, 313; tail 125.5, 157; ventrals, 187, 176; caudals, 96, 101; supralabials, 8-8, 8-8; infralabials, 10-10, 9-9; scale rows, 17-17-17 in both; left and right ovaries each with five eggs, 1 mm. or less.

Salvadora intermedia richardi Smith. One, 2 mi. E Tlaxiaco, Oaxaca (4967). Snout-vent 202; tail 71; ventrals 180; caudals 103; supralabials 9-8; infralabials 8-8; scale rows 17-17-13. This specimen combines the scale characters of *richardi* and the nominate subspecies. The best diagnostic feature is the separation of the anterior section of the nasal scale from the second supralabial, but these two scales are in contact on one side, separated on the other. The number of ventrals favors allocation with *intermedia.* Thus we are of the same opinion as Smith *(in litt.),* that the validity of *richardi* is in doubt at present.

Toluca lineata acuta (Cope). Male, 2 mi. E Tlaxiaco, Oaxaca (5244); 117 ventrals, 40 caudals, 6-6 infralabials, 7-7 supralabials, 17-16-16 scale rows, 187.5 mm. snout-vent, 51 tail. Dorsal pattern of typical transverse dark markings, but five faint dark lines discernible against light gray ground color; ventrum only slightly pigmented.

Juvenile male, 4 mi. W Zoquitlán, Puebla (5243), apparently a *T. lineata acuta* x *varians* intergrade; dorsal pattern tending toward tessellated dark markings; belly and tail immaculate, snout-vent 131.5; tail 35; ventrals, 124; caudals 46; infralabials, 6-7; supralabials, 7-7; scale rows, 17-17-17; second supralabial touching preocular on both sides.

These two specimens are, we feel, indicative of the broad area of intergradation in the *T. lineata* complex (Smith, 1943, Proc. U. S. Nat. Mus., 93:492).

Crotalus molossus nigrescens Gloyd. Adult male, 4 mi. W Zoquitlán, Puebla (5023), taken after dark in high pine forest. It is of special taxonomic interest, possessing several characters of the possibly related *C. basiliscus* (Klauber, 1952, Bull. Zool. Soc. San Diego, 26:87-88). Ventrals, 179; caudals, 26; infralabials, 17-18; supralabials, 17-17; scale rows, 33-27-23; 4 large paired scales in internasal area; 2 large paired and 19 small scales in frontal area. Number of caudals, tail length (67 mm.), and eight distinct tail rings favor allocation with *C. basiliscus oaxacus*. Number of ventrals, lack of vertebral ridge and scale bosses, and black rattle matrix are more typical of *nigrescens*. On the head this specimen not only lacks the irregular light marks characteristic of *oaxacus*, but also the posterior divergent light streaks usually seen in *nigrescens*. The poor condition of the specimen precludes exact determination of number of body blotches and color of body in general.

DEPARTMENT OF CONSERVATION, CORNELL UNIVERSITY, ITHACA, NEW YORK

FROG EGGS PARASITIZED BY DIPTEROUS LARVAE.—From August, 1956, to January, 1957, several hundred egg-clusters of *Physalaemus cuvieri* Fitzinger, were collected for studies on the biology of this frog. The collections were made in pools in the neighborhood of Sáo Paulo, Brazil.

Egg clusters were found along the shore at the water line and among the floating *Eichornia*. Spawning occurs during the night, mostly between nine and twelve p.m. The egg-clusters consist of a compact mass of white gelatin approximately 100 cc. in volume and contain an average of 500 non-pigmented eggs. During the first months of the spawning season, from early September to late November, they are very numerous, but during middle January a second spawning occurs when the clusters are only 50 cc. in volume, with an average of 300 eggs.

The clusters were collected during the morning, but only those formed the night before were taken. They were isolated in plastic bags and later transferred in the laboratory to individual jars with water. The volume of the clusters was measured and the tadpoles counted after emergence, 90 to 100 hours after spawning.

From September to November several of the clusters were observed

to be parasitized by dipterous larvae which devoured the frog embryos. From fifty to one hundred larvae live in one cluster, moving about through it in search of frog embryos which they eat. Owing to the movements of the larvae the clusters lose their consistency and tend to spread out, whereupon many of the larvae drop into the water and die, probably by drowning. The dipteran larval period lasts 4 days, during which all the frog embryos in the cluster are usually destroyed.

Full grown larvae were obtained in January clusters to which a fresh supply of frog embryos was added after the first batch was eaten. Pupation occurred at the surface of the water, where the brown pupae were found floating. The pupae were isolated in vials containing moist filter paper, following the technique used for rearing of Simulidae (blackflies). Adults emerged within 10 days and were sent to Dr. Sebastiao de Oliveira, Entomologist of the Institute Oswaldo Cruz, Rio de Janeiro, for identification. They proved to represent *Gastrops niger* Williston, 1897, of the family Ephydridae.

Oviposition of the fly was not observed, but must occur during the night or dawn, as shown by our collections. Larvae were not seen in the collected clusters, their presence being noted only after the second day in the laboratory. In the clusters collected from middle September to middle November the average infestation was approximately 5 percent, but in middle January the figure mounted to 80 percent, possibly due to the fact that clusters were scarce.—*Werner C. A. Bokermann, P. O. Box 7172, São Paulo, Brazil.*

BUFO VALLICEPS IN MISSISSIPPI.—The eastern range of this toad extends along the coast of Louisiana in the Florida Parishes (Wright and Wright, Handbook Frogs Toads, 1949: 195). According to Percy Viosca (personal communication) this toad lives on calcareous soil along the coast and rivers and is found on the Mississippi River in Pointe Coupee Parish, Louisiana, and even in southern Arkansas.

There are no published records east of Pearl River, the boundary between Louisiana and Mississippi. On June 20, 1955, the writer took *valliceps* on the east bank of Pearl River about 8 miles south of Nicholson, Mississippi. The precise locality is just south of Highway 11 and the Pearl River bridge, in Hancock County about 20 miles from the coast. Mr. Viosca also informed me that he has taken *B. valliceps* at Pearlington, Mississippi, which is about 4 miles east of Pearl River. The writer also collected specimens near Bay St. Louis, Mississippi, 15 miles farther eastward, June 20, 1955. However, there were escapees and releases of this toad from so called "Aqua-Frams" in this region two years previously. Therefore, it is not known whether these easternmost collections are based on introduced specimens or their descendants. The population of *valliceps* still exists at Bay St. Louis, Mississippi and was heard calling and seen there on the night of June 7, 1957. It seems clear *Bufo valliceps* extends naturally for a few miles into western Mississippi and is established 20 miles east of the Louisiana line. These toads are about two and a half inches long and appear to be only about half the size of adults from the south Texas coast.—*William E. Brode, Gulf Coast Research Laboratory Ocean Springs, Miss.*

A New Subspecies of the Central American False Coral Snakes (*Pliocercus*)

By HOBART M. SMITH and PETE S. CHRAPLIWY

Among the specimens secured by Mr. Thomas MacDougall in Mexico in 1956 is a single individual of *Pliocercus* from Pacific Chiapas, representing a group hitherto known only from two other specimens from Yucatán referred to a single species. We believe the Chiapas specimen represents a taxonomically distinct population.

Pliocercus andrewsi pacificus subsp. nov.

Holotype. Univ. Ill. Mus. Nat. Hist. No. 40832, a mature male, from 5000 ft., Pacific slopes of Finca Custepeque, District of Tonalá, 40 mi. ESE Tonalá, Chiapas, Mexico, Mr. Thomas MacDougall, November 18, 1956.

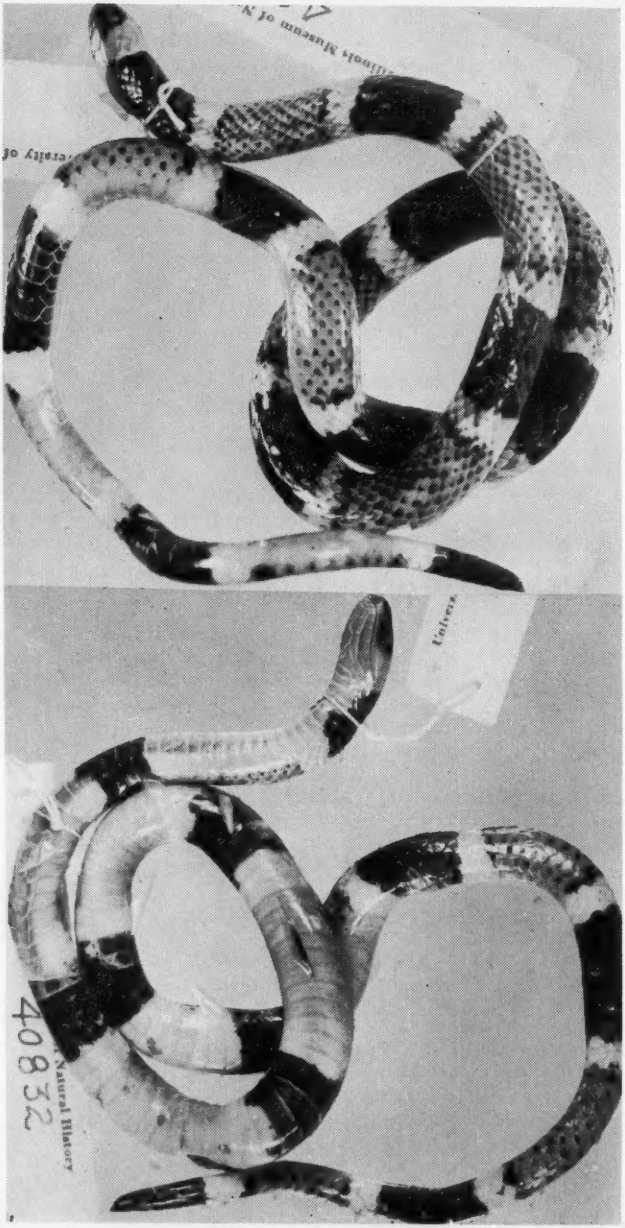
Diagnosis. A *Pliocercus* basically with a pattern of triads of rings consisting of a broad red ring bordered by white (or yellow) rings, and each triad separated from the adjacent triad by a broad black ring; related to *P. a. andrewsi,* but (a) with 8 instead of 6 to 7 black rings on body; (b) black rings on body shorter than nuchal ring, covering 5½ to 7 scale lengths instead of 8 to 11; (c) black rings covering 4½ to 5 ventrals instead of 6 to 10; and (d) narrow black border on red rings at their junction with yellow rings on dorsal scales, instead of no black border.

Description of holotype. Head scales normal; two preoculars, the lower wedged between supralabials; two postoculars; temporals 1-2; loreal single, in contact with supralabials 2 and 3, and also with lower preocular on one side; 8-9 supralabials, an extra one inserted between third and fourth on left; infralabials 9-10; anterior chinshields a little longer than posterior; latter in contact anteriorly nearly half their length; internasals 3/5 length of prefrontals.

Ventrals 127; tail incomplete; anal divided; dorsals 17-17-17; snout-vent 310 mm.; stub of tail 150 mm.

Head black above as far posteriorly as entire frontal, anterior tip of parietals and postoculars; lower half of rostral and lower third of supralabials white (yellow in life?) a white (yellow?) ring around parietals, narrowest medially, continuous with light labial border; lower surface of head white, unmarked. A long nuchal collar involving rear tips of parietals, narrowing laterally where it just fails to touch rear supralabial and extending onto lateral edges of three ventrals, incomplete ventrally by a space about one third width of ventrals. Seven other black rings on body varying in length dorsally from 5½ to 7 scale lengths, ventrally covering 4½ to 5 scale lengths; white (yellow in life?) rings covering 1½ scale lengths, unmarked; red rings immaculate below, but with a black dot at posterior apex of each dorsal scale except against white rings, where black flecks are larger and form a narrow border about ½ scale in length; spaces between black rings about 1½-2 times length of black rings. Tail marked like body but with more distinct and somewhat longer black borders on red rings.

Comparisons. The only *Pliocercus* known from Mexico with red, yellow and broad black rings is *P. andrewsi,* previously recorded from



Pl. 1. *Pliocercus andrewsi pacificus*, holotype.

Yohdzonot and Libre Unión, Yucatán. The two specimens from Yucatán have broad black rings on body, all black rings about as long as nuchal ring; in the present specimen the nuchal black ring is about the same, but those on body are all shorter (5½-7 dorsals and 4½-5 ventrals *vs.* 8-11 dorsals and 6-10 ventrals). The present specimen has a distinct, narrow black border on all red rings in dorsal zone (not on ventrals); this is not described for Yucatán *andrewsi.* In the latter, a black spot on each of first infralabials, none anywhere on ventral surface of head of the Chiapas specimen. One more black ring is on the body of the present specimen than in either from Yucatán, but this is not likely a constant difference.

The seemingly significant differences between the present specimen and those from Yucatán involve the relatively narrow black rings and perhaps the black borders of the red rings. In this genus the lengths of white and black rings are relatively constant, whereas the red rings vary to a considerable degree in length. Since the deviation of the Chiapas specimen from the pattern of the Yucatán series is greater than would be expected in a single geographic subspecies, and since that deviation is accompanied by a wide difference in geographic origin, habitat and faunistic relations, it is reasonably interpreted as indicative of a populational difference at the subspecific level.—DEPARTMENT OF ZOOLOGY AND MUSEUM OF NATURAL HISTORY, UNIVERSITY OF ILLINOIS, URBANA.

THE ROLE OF UROTOMY IN LIZARDS.—Autotomy (self-mutilation) of the tail (*i.e.,* autourotomy) is a common occurrence among lizards of certain genera. Some uncertainty reflected in the early literature as to the role of the owner of the tail in urotomy has been resolved with clear proof that in all lizards readily parting with the tail the severance is self-inflicted despite the severity of injuries otherwise inflicted; although the severance usually is a response to injury or threat of injury, the actual break is effected by the owner of the tail. The fractures must be self-inflicted as is clearly evidenced by adaptation of the tail for severance only at specific segmental planes. Non-autotomous lizards do not possess these fracture planes, do not regenerate the tail when it is broken and the break is actually effected by some extrinsic force which may be either of accidental nature or the effort of some predator.

Defensive autourotomy is well established as a common phenomenon among many lizards. Autotomy may subserve emergency dietary needs, but this has not been widely noted. The only conclusive evidence known to me is the observation by Carr and Van Hyning who "watched a captive *Eumeces laticeps* regard its tail for a moment, wiggle it tentatively, seize it in its jaws, break off the terminal inch-and-a-half, and swallow it avidly." (Carr, 1940, Univ. Fla. Publ., Biol. Ser., 3: 74-75.)

Dietary or self-induced autourotomy can rarely be conclusively verified because it must be observed, but a number of apparent cases of autophagy (self-eating) of the tail (*i.e.,* autourophagy) have been recorded. In the stomach of each of four *Scincella laterale,* Carr (*loc. cit.*) records finding a fragment of tail of the same species; each specimen had lost its tail and the part in its stomach corresponded reasonably well with the probable

dimensions of the lost part. McCauley (1945, Rept. Maryland: 45) similarly records finding in the stomach of one broken-tailed juvenile *Eumeces fasciatus* a fragment of tail corresponding with the presumed dimensions of the lost part. Any one of three possibilities may account for ingestion of a tail. It is possible (1) that in certain rare cases the ingested tail belonged to another specimen, and (a) was encountered by coincidence, or (b) was accidentally separated incidental to combat or for other reasons, or (c) was deliberately separated for food. A more reasonable possibility (2), perhaps more frequent, is loss of the tail in defensive autotomy and subsequent ingestion by the owner. The case reported by Grant (1957, Herpetologica, 13: 156) for *Eumeces skiltonianus* falls into this category. The most reasonable possibility (3), and probably the most frequent, is loss of the tail by self-induced autotomy.

It seems likely that most if not all of the 5 cases of urophagy reported by Carr and McCauley were preceded by self-induced urotomy. If so, urotomy is not so universally defensive as may have been supposed.—*Hobart M. Smith, Dept. of Zoology, Univ. Illinois, Urbana.*

YOLK RETRACTION AS A POSSIBLE CAUSE OF KYPHOSIS IN TURTLES.—A number of hypotheses have been erected to account for the occurrence of kyphosis, or "humpback," in turtles. A new hypothesis is here proposed: that late retraction of the yolk mass, or retraction of an excessively large yolk mass, or both, may cause at least some cases of kyphosis.

The mortality rate among pre-hatchlings and hatchlings which possess a large yolk mass is extremely high (Cagle, 1954, Amer. Midl. Nat., 52: 230). Cagle states that in 8 individuals of *Pseudemys scripta troostii* with excessively large yolk masses that could not be retracted, all died within the first few weeks after hatching; one individual successfully retracted the yolk, but died 1½ months later. The carapace of the latter specimen was distended at the end of this time. It seems possible that an occasional individual may survive. In very general terms the rarity of kyphotic individuals can be regarded more or less equivalent to the rarity of survival of an individual retracting a large yolk mass.

As pointed out by Smith (1947, Univ. Kansas Publ., 1: 121), "Agassiz and others have shown that the costal plates normally do not fuse with the ribs by the time of hatching; the fusion then does not occur in the embryonic stage." Smith attributes kyphosis to an abnormally early fusion of the vertebral column and costal plates, when their growth rates are presumed to be sufficiently disparate to cause a distortion of the carapace.

The present hypothesis incorporates part of that of Smith, but seeks to explain the abnormal fusion of the vertebral column and costal plates on the basis of abnormal yolk retraction, rather than by the time of fusion. It seems apparent that the pressure of a large yolk mass, retracted against the vertebral column in late developmental stages, could cause an early fusion with the costal plates; furthermore it also seems possible that even with normal timing of fusion, the retraction of a large yolk mass after hatching would exert pressure against the vertebral column and ventral surface of the carapace, and could thus cause it to grow in an exaggerated arch.—*Kenneth L. Williams, Mus. Nat. History, Univ. Illinois, Urbana.*

Notes on Snakes from the Mexican State of Sinaloa[1]

By William E. Duellman

The physiographic region embracing the coastal lowlands of Sinaloa and southern Sonora is one in which there is a blending of edaphic conditions, vegetation and fauna of the desert regions lying to the north and of the tropical lowlands lying to the south. The southern part of Sonora is usually considered the northern limit of the Neotropical Region in western Mexico, or, as defined by Schmidt (1954, Quart. Rev. Biol., 29: 322-331), the northern terminus of the Caribbean Transition Subregion. There is a noticeable difference in the snake fauna of central and northern Sonora as compared with that of central and southern Sinoloa. In the intermediate region *Lichanura, Gyalopion,* and *Micruroides* reach the southern limits of their distribution. On the other hand, several genera of southern distribution range no farther north; these include *Drymarchon, Drymobius, Imantodes, Leptodeira, Leptophis, Pseudoficmia* and *Micrurus.* The differences are even more impressive when other groups of reptiles and amphibians are included. Six genera of lizards and one of frogs reach their southern limits of distribution in this area; one genus of lizards and nine of frogs reach their northern limits here.

In southern Sonora and in most of the lowland region of Sinaloa the vegetation consists of thorn scrub of varying density; dominant trees are *Acacia, Crescentia,* and *Prosopus.* To the north in central Sonora the vegetation is typical of the Sonoran desert, consisting of sparse grass, clumps of scrubby trees *(Larrea, Cercidium,* etc.) and many cacti. Although columniferus cacti are present in southern Sonora and in Sinaloa, the cholla and ocotillo, characteristic of the Sonoran desert, are absent. Southward from southern Sinaloa more tropical elements appear in the lowland vegetation, which is higher and denser than that to the north.

During the course of field work in Mexico in 1956 brief stops were made at Mazatlán, Sinaloa. On each occasion road collecting at night on the highway north of the town resulted in the capture of many snakes. At the time of the first visit (May 11-12) the weather was very hot and dry, but the two nights of collecting netted 27 snakes. On August 14 after a heavy rain 16 snakes were collected. Some of these specimens represent species presently known from few specimens and restricted ranges, and others represent species heretofore unrecorded from the state of Sinaloa. All specimens are in the collections of the University of Michigan Museum of Zoology. Although most of the specimens reported here were collected in the vicinity of Mazatlán in 1956, certain others collected by other field workers and contained in the collections of the University of Michigan Museum of Zoology are included.

For their assistance in the field I wish to thank my wife, Ann S. Duellman and Richard E. Etheridge. Field work in Mexico was made possible by a grant from the Penrose Fund of the American Philosophical Society with the cooperation of the University of Michigan Museum of Zoology.

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1. Contribution No. 5 from the Department of Biology, Wayne State University, Detroit 2, Michigan.

Elaphe triaspis intermedia Boettger

A single male, 13.8 mi. NNW Mazatlán, the first record from Sinaloa. Ventrals 241, caudals 100; dorsal ground color in life greenish yellow, dorsal markings dull olive; a U-shaped mark on parietals, a round spot near antero-lateral corner of each parietal, a small inverted U-shaped mark on frontal and a transverse bar on anterior edges of superaoculars and frontal and posterior edges of prefrontals and preoculars.

Gyalopion quadrangularis Günther

Two specimens DOR, one 4.2 mi. NNW Mazatlán and one 24 mi. NNW Mazatlán. Heretofore known only from the type from Presidio, Sinaloa. Ventrals 119♂, 125♀; caudals 26♂ 23♀; body 180 mm. ♂, 215 ♀; tail 29 ♂, 28 ♀; upper and lower labials 7; first upper labial fused with nasal; anal single; dorsal ground color brick red; sides of head, rostral and ventral surfaces cream; 25 and 32 rounded middorsal black spots outlined with pale yellow; 6 or 7 middorsal spots on tail; anterior body spot 5 scales in length, 6 width; spots progressively smaller posteriorly; a black Y-shaped mark covering head, arms of the Y originating on suture between third and fourth upper labials, passing over supraoculars and lateral part of frontal, joining on posterior part of frontal, thence the broad base of the Y extending posteriorly to connect with a black nape band four to five scales in length.

The present specimens agree with the type description given by Günther (1893, Biol. Centr.-Amer.: 99). In scutellation they closely approach *Gyalopion desertorum* Taylor, known from scattered localities in southern Sonora and northern Sinaloa. Four males of *desertorum* average 128 ventrals and 29 caudals; four females 131 ventrals and 26 caudals. Taylor (1936, Proc. Biol. Soc. Washington, 49: 51-54) diagnosed *desertorum* as having a single anal plate; one specimen of *desertorum* from Alamos, Sonora, has a divided anal whereas specimens of *quadrangularis* have a single anal plate. Striking differences in coloration serve to distinguish the two rather widely separated populations; *desertorum* has a light brown or cream ground color with brown to black spots in contrast to the red ground color with black spots of *quadrangularis*. Both have the Y-shaped mark on the head. Additional material from the 250 mile gap in the ranges may show that the two populations represent the same species.

Hypsiglena torquata torquata Günther

Seven specimens, 6 to 38 mi. NNW Mazatlán. Five females average 166 ventrals, 52 caudals; two males 161 and 168 ventrals, 52 caudals. The largest female snout-vent length 386 mm., tail 63.

The taxonomic allocation of *Hypsiglena* from Sinaloa and southern Sonora has been a point of controversy for more than a decade. Tanner (1944, Great Basin Nat., 5: 25-92) treated *ochrorhyncha* and *torquata* as distinct species. Bogert and Oliver (1945, Bull. Amer. Mus. Nat. Hist., 83(6): 297-426) showed that there was continuous clinal variation in scale characters from Arizona southward to Colima and suggested that the two forms should be considered subspecies. Smith and Van Gelder (1955, Herpetologica, 11: 145-149) also expressed the opinion that *ochrorhyncha* should be a subspecies of *torquata*. The most noticeable

character used to distinguish the two is the nape pattern: *torquata* has a light nape band and *ochrorhyncha* does not. Of the seven specimens from near Mazatlán, three have the light nape band characteristic of *torquata,* one has a divided nuchal blotch and a median nape stripe somewhat like the pattern of *ochrorhyncha,* one has a light nape band and a complete dark nape stripe and two have a light nape band and incomplete nape stripe. On the basis of these specimens it appears as though the area of intergradation between *torquata* and *ochrorhyncha* may extend as far south as Mazatlán. More material is needed to define accurately the variation and ranges of the various populations of *Hypsiglena,* a genus apparently composed of a single wide-spread highly variable species.

Imantodes latistratus Cope

Four specimens collected on road 6 to 31 mi. NNW Mazatlán are the first reported from Sinaloa. All males, 215-223 (av. 219) ventrals, 118-127 (av. 123) caudals. Living specimens are beautifully marked: ground color grayish white anteriorly fading to light tan posteriorly; dorsal blotches pink-rose anteriorly changing to reddish brown at midbody and to brown posteriorly; eye pale rose. Blotches 48 to 50 on body, first 18 to 20 five or six scales in length, edged in black, extending laterally to first scale row; blotches smaller posteriorly, extending laterally to third or fourth scale row; largest individual, body 510 mm., tail 208.

Leptodeira punctata Peters

Eight 2-4 mi. NNW Mazatlán, and one 19 mi. NNW Mazatlán. Ventrals av. 153 in 5 males, 157 in 4 females; caudals av. 64 in 5 males, 59 in 4 females; largest male body 410 mm., tail 128; largest female, 432, 121; dorsal ground color varying from pale orange-tan to straw color fading to yellow on sides and cream on venter; five or six longitudinal rows of small brown spots on dorsals; iris grayish yellow.

Masticophis bilineatus Jan

One, 10 mi. W Concordia on road to La Union, the first record for the state of Sinaloa. A female, 186 ventrals, 129 caudals, body 900 mm., tail 380. In diagnostic characters it resembles the subspecies *lineolatus* (Hensley, 1950, Trans. Kans. Acad. Sci., 53: 270-288) in having a spotted chin, sublateral dark lines joined anteriorly, and a narrow dorsolateral light stripe on upper third of third scale row and lower third of fourth scale row. Dorsolateral light stripe beginning on right side on 13th scale behind last upper labial and on left side on 15th scale; stripes faint posteriorly, disappearing on posterior fourth of body leaving all scales light with a dark brown spot on anterior and posterior corners of each. Hensley *(op. cit.:* 275) remarked that the range of *lineolatus* may be restricted to the Ajo Mountains in southern Arizona. Zweifel and Norris (1955, Amer. Midl. Nat., 54: 242) reported specimens from Guirocoba, Sonora, that resemble *lineolatus* in certain characters. The appearance of characters "diagnostic" of *lineolatus* throughout the range of the species indicates that these characters probably are highly variable and do not constitute a basis for the recognition of subspecies.

Pituophis catenifer affinis Hallowell

One male, 9 mi. SE Guaymuchil; 226 ventrals, 57 caudals, 50 brown

body blotches narrowly outlined with black. Previously this species has been reported in Sinaloa from Ahome (Bogert and Oliver, *op. cit.*) and north of Mazatlán (Zweifel, 1954, Herpetologica, 10: 147).

Rhinocheilus lecontei antoni Dugès

Four specimens, on road at night, 15 to 28 mi. NNW Mazatlán. In 2 males and 2 females, respectively, ventrals 196, 202, 193, 195; caudels 48, 47, 44, 43; anterior 34, 38, 26, 26 caudals undivided; body 595, 635, 414, 290 mm.; tail 99, 103, 65, 46. Adults in life with wide black and narrower coral red bands; black bands varying from 15 to 19 (av. 16.5); in juvenile, light bands cream with only a slight indication of pink in the middle of each.

Trimorphodon paucimaculatus Taylor

Five males, 2 to 36 mi. NNW Mazatlán. Ventrals 231-247 (av. 238), caudals 78-91 (av. 84.5), and dorsal body blotches 21-26 (av. 23). Snout-vent between 380 mm. and 455 in four, 902 in one; tail 210 in latter. In life, smaller individuals with ground color light grayish tan, blotches light chocolate brown with tan centers outlined with grayish white; largest individual with dirty yellowish tan ground color and light chocolate brown blotches.

The resemblance of *paucimaculatus* to *lambda* toward the north in Sonora and Arizona and to *biscutatus* toward the south from Jalisco to Nicaragua shows that additional material from the intermediate areas may prove that these populations should be treated as subspecies.

Natrix valida valida Kennicott

Five specimens, two from 1 mi. NNW Mazatlán, two from Arroyo Sonalona, 18.5 mi. E Culiacán, and one from Madero on a tributary of the Río Baluarte. Four males average 140 ventrals, 74 caudals; single female 144 ventrals, 77 caudals. Largest specimen, a male, body length 512 mm., tail 167. All dull grayish tan above and dirty cream below; small dark spots arranged in four longitudinal rows on body.

Micruroides euryxanthus australis Zweifel and Norris

One adult male, 16.3 mi. NNW Mazatlán. This is the first record of the genus in the state of Sinaloa and provides a range extension of about 300 miles south of Guirocoba, Sonora. Ventrals 210, dorsal red scales 113; both characters are beyond the range of variation of the type series from southern Sonora as given by Zweifel and Norris (*op. cit.*: 246). There are 13 black and 13 red rings on body; white rings never more than one scale in width.

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Observations on the Life History of the Cuban Lizard, *Anolis lucius*

By JERRY D. HARDY, JR.

Anolis lucius Duméril and Bibron, a rather common, widespread lizard of Cuba, has, in the past few years, been the subject of considerable comment among students of West Indian herpetology. These authors have pointed out a number of rather striking peculiarities which tend to set *lucius* off as distinctly unique within the genus. Smith and Willis (1955, Herpetologica, 11: 86-88) mention the cavernicolous habitat of the form and describe a population from Buenaventura, Oriente Province, which seems incapable of metachromic changes. Schwartz and Ogren (1955, Herpetologica, 12: 9-110) point out that it has a distinctly audible voice, squeaking loudly when captured; and Williams and Hecht (1955, Science, 122 (3172): 691-692) comment on the occurrence of "windows" (highly modified palpebrals) in the lower eyelids of this form and the closely related *Anolis argenteolus* of eastern Cuba. The only recorded comment on the life history of the form, however, is in Barbour (1930, Bull. Mus. Comp. Zool. 70 (3): 105-144) who quotes Dunn (1926. Copeia 157: 153-4) commented briefly on the eggs of the species, stating that they were stuck to limestone cave walls in a manner similar to certain gecko eggs. Barbour (1930. Bull. Mus. Comp. Zool. 70(3): 105-144) quoted Dunn's observations, adding that the eggs were brittle.

The eggs of *Anolis lucius* were first observed by the author in September, 1955, at a cave approximately seven miles west of Trinidad, Las Villas Province, along the east slope of the Guanayaro River valley. The cave is situated several hundred yards northeast of a locally well-known boa cave (Hardy, 1957, Copeia, 2: 151-152). The *lucius* cave is located at the base of an oblong entrance pit about fifteen feet deep which opens in an area of dense jungle. To the east the pit slopes into a large cavern having a fifty-foot ceiling which is penetrated at several points by small chimneys leading to the outside. Westward it merges into a much smaller, narrow cave which is divided by a large shelving ledge of limestone into two rooms, one above the other. The lower room is approximately forty feet long, twelve feet wide, and ten feet high.

In 1955 and on all subsequent visits, *Anolis lucius* was observed abundantly in this room, never in the upper room (which was occupied by *Tarentola americana*) and only rarely in the nearby large cavern at the eastern end of the entrance pit. The large cavern was a good source of *Eleutherodactylus, Tropidophis* and *Hyla septentrionalis,* but none of these forms, with the exception of a single *Eleutherodactylus,* has been observed in the *lucius* cave.

In 1955 several eggs were opened and the embryos within identified as those of *Anolis lucius.* It was noted that the eggs were not brittle as Barbour (*op. cit.*) has supposed, but were soft and flexible, similar to the eggs of many North American lizards.

In September, 1956, the same cave was visited, but no eggs were observed clinging to its walls. Again on June 22, 1957, no fertile eggs were seen, but several clutches of egg shells were attached to the cave ceiling. These were distributed over an area of one square yard and

formed three groups of two, three, and seven eggs each. In all cases the eggs were stuck fast to the cave wall and to each other. The groups of eggs were wedged in narrow crevices extending up between small stalactites.

The egg shells apparently fall from the ceiling shortly after hatching, and accumulations of empty shells on the floor indicate the area selected for deposition. In the cave described, three distinct groups of fallen egg shells were noted. These tended to form circular or oval patterns on the otherwise bare cave floor. The eggs were most abundant in the center of each deposit, diminishing in numbers gradually toward the periphery. A one square foot plot was marked off in the center of each deposit and the eggs counted. The three plots yielded 78, 95 and 106 shells. These data strongly suggest that laying takes place in limited areas within the cave and that the same area is utilized over long periods.

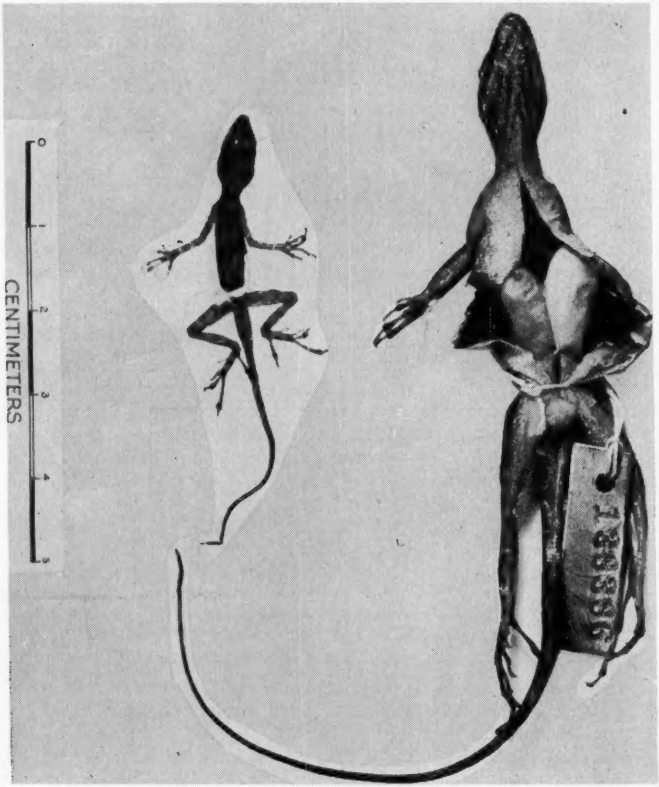

Fig. 1. *Anolis lucius.* Dissected to show paired eggs. The darker egg is sterile. A hatchling shows relative size.

Egg or egg shell distributions were noted in three other caves, all located in the same limestone ridge as the first described and all within one half mile of each other. The first of these three produced the most shells of all, deposited in a fifteen by twelve foot oval on the floor where 131 were counted from a one square foot plot located approximately in the center of the mass. The ceiling of the cave above the egg deposit was slightly over four feet high, whereas the cave at this point was fifty feet wide and extended inward from the eggs for several hundred yards. Another smaller cave yielded two egg deposits in a large, low room. These deposits were six and eight feet in diameter and were separated by forty feet of bare cave floor.

The last cave, visited June 23, 1957, lies just a few yards north of the road to Trinidad one quarter mile east of the Guanayaro store. It is a narrow tunnel extending eastward about three hundred yards. The number of empty shells in this cave was negligible, but a single fertile egg containing a well-developed embryo was observed. Immediately behind this egg were five shells which had apparently hatched recently. Adult *lucius* were abundant at the entrance and deep within the cave.

On June 24, 1957, a clutch of ten eggs was discovered in the same area. Since it was impossible to remove them directly from the wall without injury, an attempt was made the following day to remove the entire limestone crevice in which they were supported. This resulted in the breakage of three eggs, two containing well formed embryos. The other contained an individual apparently ready for hatching. The embryos were 35.5 and 32.0 mm. long and the third 61 mm. in total length.

The seven unbroken eggs were placed in a jar containing moist paper and removed from the cave. Oblong in shape, they varied from 14 to 16 mm. in greatest length, with a mean of 14.1.

On June 27 (four days after the eggs had been collected) a single egg hatched. The young lizard differed from the adults only in being much more brightly marked and in having a definite ventrolateral white stripe running from the base of the arm to the insertion of the hind limb. This same pattern, in a much less pronounced form, is occasionally observed on young females. The specimen, apparently a female, died on July 6 and was, at that time, 69 mm. in total length.

The remaining eggs were flown to Baltimore, Maryland, where another hatched on July 15. It measured 60.5 mm. and had grown to a length of 63.0 mm. at the time it died on July 27.

Utilization of rather limited areas for nest sites by large numbers of *Anolis lucius* is probably the result of gregarious behavior brought about by the highly specialized habitat selection of the species as well as the possible effects of environmental conditions (temperature, humidity, and light) on the eggs. Temperatures taken directly beneath the egg sites in caves containing fertile or recently hatched eggs ranged from 26 to 29°C. Seven other caves in the same region, none of which showed indications of *lucius* egg sites, registered temperatures ranging above and below the optimum range of 26-29°C as far as 24 and 35°C. In the first *lucius* cave studied, the temperature was 29°C., whereas the twilight zone of the large nearby cavern at the opposite end of the entrance pit was 24 degrees.

The four *lucius* caves all run east and west, whereas the seven others run principally north and south. The significance of this observation cannot be determined until much more data are available; a correlation may possibly exist between egg site selection and the amount of light filtering into the cave. In all caves but the last the eggs were found near the entrance in the twilight zone. In the last cave the eggs were deposited one hundred yards from the entrance, but a moderate amount of light filtered in through a small opening in the cave ceiling.

It has been impossible thus far to determine the humidity in the *lucius* caves, but it was noted that the eggs shrink almost immediately upon exposing them to outside air. It can be safely assumed that the moisture content of the air in the cave is of importance in egg development.

The occurrence of relatively large clutches of *lucius* eggs is of considerable interest in view of the fact that the Anoles typically lay no more than two eggs, generally one. Since the single large clutch examined yielded three embryos, each obviously in a different stage of development, it seems apparent that the large clutches are formed by a number of females each depositing one or two eggs.

Twenty-two females in the collection of the United States National Museum were examined. This series represents three different collections made over a period of four years. Part of the specimens are from Trinidad and part from Soledad near Cienfuegos. Both of these areas are in Las Villas Province approximately forty miles apart and both are situated on the southern coast of Cuba south of the Trinidad mountain range.

The specimens were opened and the numbers of eggs noted. In a lot of 7 collected in December, 1954, none contained eggs; 11 of Sept., 1956, 9 with eggs; and 4 of June, 1957, 3 with eggs.

Two types of eggs were immediately distinguishable: normal, which were white, leathery and soft; and light brown, hard, crumbly and obviously infertile. Of twelve individuals containing eggs, seven contained one normal and one abortive egg, the normal egg always on the left; one contained a normal egg on the right and two abortive eggs, one on the right anterior to the normal egg and one on the left. In three cases a single normal egg lay along the mid-line of the abdomen and abortive eggs were lacking. In one case a single abortive egg was found on the left side. The normal eggs, when removed, ranged in length from 13 to 21 mm. with a mean of 15.3 mm. The abortive eggs ranged from 5 to 15 mm. with a mean of 10.1.

The snout-vent lengths of the gravid females range from 42.2 to 52.9 mm. with a mean of 49.9 mm. The group of seven specimens collected during December, 1954, all of which lack eggs, are of similar size (45.6-57.7 mm.; mean, 52.4 mm.) Assuming then that these are mature females one can justifiably conclude that egg laying is seasonal and does not, as might be expected, occur throughout the year.

While taking notes on eggs at the first *lucius* cave June 22, 1957, a pair of breeding adults was noted. The pair lay side by side about eight feet up on the wall in the twilight zone of the cave, facing head downward in a concave slope. The front feet of both individuals were on the wall. The male lay to the right of the female with his body bowed

slightly outward and grasped the female just behind the head with his jaws. His tail crossed beneath that of the female in the region of the vent, then bent sharply forward along her left side. The tail of the female projected straight back and undulated spasmodically throughout the course of the observations. This position was maintained for approximately three minutes when the pair separated, running briskly in opposite directions.

The similarity of egg deposition in *lucius* and the geckos is striking. The incubation period is not yet known but is probably in excess of twenty-two days (the length of time between obtaining a clutch of eggs and the hatching of one of these in Baltimore). Egg laying is probably limited to the warmer months, although the entire reproductive period may be rather extensive since hatching eggs and breeding adults have both been observed on approximately the same date.

I wish to express my appreciation to Dr. Robert Simmons of Baltimore, Maryland, whose kind cooperation and interest in my Cuban studies made possible the 1957 trip to Trinidad upon which most of these comments are based.

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DISTRIBUTION OF *CARPHOPHIS AMOENUS* IN MISSISSIPPI. —*Carphophis amoenus helenae* Kenicott was originally described from Monticello, Lawrence Co., Mississippi. It has subsequently been reported elsewhere in the state by a number of investigators. Cook (1954, Snakes of Mississippi, State Game and Fish Comm., p. 5) states, in summarizing the known distribution up to that time, that the snake is common only in the northeastern part of the state and in the northern and eastern parts of the Short-Leaf Pine Belt; occasionally found in the Long-Leaf Pine Belt (Poplarville and Hattiesburg). Smith and List (1955, Amer. Midland Nat., 53(1): 121) cite records from 16 miles North of Vancleave, Jackson Co., from Charleston, Tallahatchie Co., and in Yazoo Co. Wright and Wright (1957, Handbook of Snakes, Vol. 1, p. 105) indicate a definite hiatus of perhaps 100 miles in extent between the known range in northern Mississippi and the range as known in the southern part of the state. The possibility that the subspecies does actually exhibit a disjunct distribution in Mississippi would not seem improbable on the basis of the above distributional data. However, on April 27, 1957, we collected a specimen of this snake near Bonita, Lauderdale Co., Miss. (DEF No. 903). Bonita is located almost midway between the two supposed allopatric ranges mentioned above. The occurrence of the animal at this locality would appear to preclude the existence of a hiatus and would seem rather to indicate a more or less continuous distribution over the state. We have obtained other specimens from 4 mi. S. West Point, Clay Co. and 1 mi. N. Starkville, Oktibbeha Co. (DEF Nos. 907 and 909). The latter was found in company of a *Tantilla coronata,* under the same log. None of the aforementioned Worm Snakes shows evidence of intergradation with *C. a. amoenus* as might be expected on the basis of the range as depicted by Wright and Wright (*ibid*).—*Denzel E. Ferguson and Harold R. Bancroft, Department of Zoology and Entomology, Mississippi State College, State College, Mississippi.*

THE GECKO-LIKE HABITS OF *ANOLIS LUCIUS*, A CUBAN ANOLE.—Smith and Willis (1955, Herpetologica, 11 (2): 86-87) briefly mentioned the cavernicolous habitat and "gecko-like actions" of *Anolis lucius* Duméril and Bibron. The resemblance of this Cuban anole to a gecko, in both gross morphology and behavior, warrants additional comment.

The species was found to be abundant in a bat cave near Matanzas, Matanzas Province, on May 21, 1951; and in another bat cave near San Cristóbal, Piñar del Rio Province, on February 2-5, 1956. Like geckoes, the anoles were clinging to the rock walls of the caverns, mostly in the twilight zone or in areas where the ceiling was broken by shafts. They were not found in the deeper, completely dark recesses of the caves. When disturbed, some ran rapidly over the walls or slipped into cracks, while others flattened out, motionless, against the rock. Several were noted on the cave ceiling.

The specimens of Smith and Willis were all collected by the latter in a cave, and these authors suggested that the species was exclusively cavernicolous. This is not the case. At the San Cristóbal locality, some of the anoles were found outside the cave in full sunlight, on limestone outcrops. These individuals sought safety in fissures of the rock and beneath tangles of vines. The lizards on the outside were shy, quick to withdraw at the collector's approach; they could easily have been overlooked. Barbour and Ramsden (1919, Mem. Mus. Comp. Zool., 47 (2): 139) stated that *Anolis lucius* dwelt about cave mouths and occasionally upon tree trunks of trees growing on the "paradones." Barbour (1937, Bull. Mus. Comp. Zool., 82 (2): 129) reported the species from "limestone cliffs and open caves;" he made a similar comment in several other publications. Schwartz and Ogren (1956, Herpetologica, 12 (2): 99) found specimens both in caves and on outcropping rocks. Evidently the species is not completely cavernicolous, but it does appear to be confined to limestone outcrops. Caves seem to provide the optimum habitat.

When specimens of *Anolis lucius* were grasped, they often squeaked. Such behavior heightened the lizard's resemblance to a gecko, for geckoes of many species will squeak when restrained, whereas most anoles are considered to be voiceless. It should be noted, however, that some anoline lizards are more vocal than has generally been realized. Two Jamaican species, *Anolis grahami iodurus* Gosse and *A. opalinus* Gosse, utter a sharp squeak when in distress or when fighting (Grant, 1940, The Herpetology of Jamaica. II. The Reptiles: 88); and the Cuban *Deiroptyx vermiculatus* (Duméril and Bibron), which seems rather closely related to *A. lucius,* has quite a repertoire of sounds (Neill and Allen, 1957, Nature Magazine, 50 (1): 40, 52).

When grasped, our specimens of *Anolis lucius* would also writhe and try to bite. They had the "feel" of geckoes, being muscular and soft-skinned. (In this species, as in many geckoes, the scalation is so finely granular that the skin seems velvety.) As the lizard struggled, one felt both sharp claws and soft, adhesive digital pads; again a gecko was called to mind.

The snout of *Anolis lucius* is comparatively short, the head broad at the temples, the eye large. A remarkably similar head shape is seen in many geckoes of such genera as *Gymnodactylus* and *Hemidactylus*. The resemblance to a gecko is belied, however, by the large throat fan, the long limbs and the slender, vertically compressed tail.

The eggs of *Anolis lucius* are brittle-shelled and chalky white, attached singly or in groups of two or three to cave walls and crannies (Dunn, 1926, Copeia, No. 157: 153-154; Barbour, 1930, Bull. Mus. Comp. Zool. 70 (3): 109, 133). Thus in its manner of oviposition this lizard is strikingly like a gecko.

Smith and Willis (*op. cit.*) reported considerable variation in Anolis *lucius* as regards tail shape; in some specimens the caudal appendage was but slightly compressed while in others it was keeled above. Such variation is not peculiar to *A. lucius*. In the Cuban *A. s. sagrei* Duméril and Bibron, the tail varies from vertically compressed to distinctly "finned." Cochran (1941, Bull. U. S. Nat. Mus., No. 177: 132) found tail shape to be variable in *A. ricordi* of Hispaniola. The height of the tail fin varies, perhaps geographically, in *A. cristatellus* of Puerto Rico and the Virgin Islands (Grant, 1931, Jour. Dept. Agr. Porto Rico, 15 (3): 220-221; 1932, *ibid.*, 16 (3): 332).

The anoles collected by Willis bit and mangled each other in a collecting sack. Ours, kept for several weeks in a roomy wire cage, showed no such pugnacity although as many as 24 were caged together at times. Smith and Willis suggested that *Anolis lucius* was unique in its belligerency toward others of its kind. However, Grant (1940, *loc. cit.*) had remarked of the Jamaican *A. grahami iodurus*, "If several sooty-black males are held in one hand they will squeak and fight. If an *A. garmani* is held with them, the others will attempt to attack it." Enforced proximity, coupled with restraint, may evoke the bellicose reactions from these lizards. Examples of the Cuban *A. equestris* Merrem often will mangle other anoles in a collecting bag.

The San Cristóbal cave was inhabited by a barn owl, *Tyto alba* subspecies, which was seen to fly out through a hole in the cavern roof. This bird is well known to inhabit caves of the West Indies, and to prey upon bats and lizards therein. It may be an important predator upon *Anolis lucius*. At the Matanzas locality, a gecko, *Tarentola americana* (Gray), was taken on rocks outside the cave. This lizard, a cave dweller at times, may be a competitor of the anole. However, within our experience *T. americana* is not seen in numbers like *A. lucius*. The latter appears to be far more successful in the cavernicolous habitat.—E. ROSS ALLEN and WILFRED T. NEILL, *Research Division, Ross Allen Reptile Institute, Silver Springs, Florida.*

POSSIBLE OVERWINTERING OF A TURTLE EGG IN EAST-CENTRAL ILLINOIS.—A turtle still retaining a trace of the umbilical stalk was collected by the author April 18, 1957, 3 miles south of Oakwood, Vermilion County, Illinois. The specimen was identified as *Chrysemys picta marginata x belli,* but tending toward *marginata.*

Carapace flexible, length and width 21 mm.; plastron length 19, width 15, height of shell 11, navel opening an elongate rhomboid, 5 by 2; egg tooth intact; navel opening unhealed; a trace of yolk sac.

Cagle (1954, Amer. Midl. Nat., 52: 230) suggests that the egg tooth and unhealed navel openings are not unusual characteristics in overwintered hatchlings. It is believed, however, that this specimen had overwintered in the egg and not as a hatchling since it possessed a flexible carapace. No reference has been found to the chronology of carapace ossification in *C. picta,* but Cagle states in reference to *Pseudemys scripta troosti* (1950, Ecol. Mon., 20: 43) that the carapace is quite firm 2 to 3 days after yolk retraction, and that in 10 of 58 turtles studied yolk retraction was completed before hatching, and after hatching in 48.

It appears that overwintering of *hatchlings* is fairly common in Louisiana and southern Illinois (Cagle, 1950, *op. cit.:* 44) whereas there are only occasional reports farther north; however, the reports that suggest overwintering of the eggs are all from the more northern states: Michigan (Hartweg, Copeia, 1944: 20), Connecticut (Finneran, Copeia, 1948: 126), Minnesota (Breckenridge, 1944, Rept. Amph. Minn.: 182), northern Indiana (Newman, 1906, Journ. Comp. Neurol. Psych., 16: 126-152).

Hartweg suggested (Copeia, *op. cit.:* 22), in reference to turtles of the Michigan area, that adverse weather conditions and not late egg-laying or late hatching, are probably the main factor causing overwintering of hatchlings. On the other hand there appears to be a definite geographic cline in overwintering habits, with the frequency of overwintering in hatchlings diminishing from south to north; this could suggest a correlation with the depth to which the soil freezes.

Likewise there appears to be a definite, but *reverse,* geographic cline in overwintering of eggs, seemingly in correlation with the shorter activity seasons toward the north, providing lesser opportunities for full development of the embryo.

It is not, however, implied that there is a greater resistance to low temperatures in the embryo than in the hatchling, nor that the overwintering of the egg is more common toward the north than overwintering of the hatchling. The geographic trends differ because there are two different influences affecting the general occurrence of the overwintering hatchlings and eggs; depth of the frost line controls the frequency of successful overwintering in either state, and length of the period of activity controls the extent of prehibernal development.—*Kenneth L. Williams, Museum of Natural History, Univ. Illinois, Urbana.*